THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 742-2005

WINNIPEG WATER TREATMENT PROGRAM - SUPPLY AND INSTALLATION OF WATER TREATMENT PLANT PROCESS MECHANICAL & ELECTRICAL

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PART B - BIDDING PROCEDURES

B1. PROJECT TITLE

B1.1 WINNIPEG WATER TREATMENT PROGRAM - SUPPLY AND INSTALLATION OF WATER TREATMENT PLANT PROCESS MECHANICAL & ELECTRICAL

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 12:00 noon Winnipeg time, May 26, 2006.

B2.2 Bid Submissions determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.

B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

B3. SITE INVESTIGATION

B3.1 Further to GC:3.1:

B3.1.1 The Contract Administrator or an authorized representative will be available at the Site from 1:00 p.m. to 2:00 p.m. on April 18, 2006 to provide Bidders access to the Site.

B3.1.2 The Contract Administrator or an authorized representative will be available at the City Warehouse from 2:30 p.m. to 3:00 p.m. on April 18, 2006 to provide Bidders access to the City Warehouse.

B3.2 The Bidder is advised that the pickup of City Supplied Equipment will be made at the City Warehouse, and limited City supplied loading facilities exist at this location.

B3.3 The Bidder shall not be entitled to rely on any information or interpretation received at the Site investigation unless that information or interpretation is the Bidder's direct observation, or is provided by the Contract Administrator in writing.

B4. ENQUIRIES

B4.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.

B4.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.

B4.3 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.

B4.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.

B4.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B4 unless that response or interpretation is provided by the Contract Administrator in writing.

B5. ADDENDA

B5.1 The Contract Administrator may, at any time prior to the Submission Deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.

B5.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B5.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

B5.2.2 The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Branch internet site for addenda shortly before submitting his Bid.

B5.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 10 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

B6. SUBSTITUTES

B6.1 The Work is based on the Plant, Materials and methods specified in the Bid Opportunity.

B6.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.

B6.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least seven (7) Business Days prior to the Submission Deadline.

B6.4 The Bidder shall ensure that any and all requests for approval of a substitute:

(a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the Plant, Material or method as either an approved equal or alternative;

(b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;

(c) identify any anticipated cost or time savings that may be associated with the substitute;

(d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance;

(e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the proposed work schedule and the dates specified in the Supplemental Conditions for Substantial Performance and Total Performance.

B6.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his sole discretion grant approval for the use of a substitute as an “approved equal” or as an “approved alternative”, or may refuse to grant approval of the substitute.

B6.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, only to the Bidder who requested approval of the substitute.

B6.6.1 The Bidder requesting and obtaining the approval of a substitute shall be entirely responsible for disseminating information regarding the approval to any person or persons he wishes to inform.

B6.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.

B6.8 If the Contract Administrator approves a substitute as an “approved alternative”, any Bidder bidding that approved alternative shall base his Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B15.

B6.9 No later claim by the Contractor for an addition to the Total Bid Price because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

B7. BID SUBMISSION

B7.1 The Bid Submission consists of the following components:

(a) Form A: Bid;

(b) Form B: Prices;

(c) Form G1: Bid Bond and Agreement to Bond, or
Form G2: Irrevocable Standby Letter of Credit and Undertaking, or
a certified cheque or draft;

B7.2 All components of the Bid Submission shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely in ink, to constitute a responsive Bid.

B7.3 The Bid Submission shall be submitted enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address.

B7.3.1 Samples or other components of the Bid Submission which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder’s Bid Submission.

B7.4 Bid Submissions submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.

B7.5 Bid Submissions shall be submitted to:

The City of Winnipeg
Corporate Finance Department
Materials Management Branch
185 King Street, Main Floor
Winnipeg MB R3B 1J1

B8. BID

B8.1 The Bidder shall complete Form A: Bid, making all required entries.

B8.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his own name, his name shall be inserted;

(b) if the Bidder is a partnership, the full name of the partnership shall be inserted;

(c) if the Bidder is a corporation, the full name of the corporation shall be inserted;

(d) if the Bidder is carrying on business under a name other than his own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B8.2.1 If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B8.2.

B8.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.

B8.4 Paragraph 12 of Form A: Bid shall be signed in accordance with the following requirements:

(a) if the Bidder is a sole proprietor carrying on business in his own name, it shall be signed by the Bidder;

(b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;

(c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers and the corporate seal, if the corporation has one, should be affixed;

(d) if the Bidder is carrying on business under a name other than his own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B8.4.1 The name and official capacity of all individuals signing Form A: Bid shall be printed below such signatures.

B8.4.2 All signatures shall be original and shall be witnessed except where a corporate seal has been affixed.

B8.5 If a Bid is submitted jointly by two or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid Submission and the Contract, when awarded, shall be both joint and several.

B9. PRICES

B9.1 The Bidder shall state a price in Canadian funds for each item of the Work identified on Form B: Prices, Alternative 1 and/or Alternative 2.

B9.1.1 Notwithstanding GC.12.2.3(c), the price on Form B: Prices shall not include the Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable.

B10. QUALIFICATION

B10.1 The Bidder shall:

(a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba;

(b) be responsible and not be suspended, debarred or in default of any obligation to the City;

(c) be financially capable of carrying out the terms of the Contract;

(d) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract;

(e) have successfully carried out work, similar in nature, scope and value to the Work;

(f) employ only Subcontractors who:

(i) are responsible and not suspended, debarred or in default of any obligation to the City (a list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt); and

(ii) have successfully carried out work similar in nature, scope and value to the portion of the Work proposed to be subcontracted to them, and are fully capable of performing the Work required to be done in accordance with the terms of the Contract;

(g) have a written workplace safety and health program in accordance with The Workplace Safety and Health Act (Manitoba);

B10.2 Further to B10.1(g), the Bidder shall, within three (3) Business Days of a request by the Contract Administrator, provide proof satisfactory to the Contract Administrator that the Bidder has a workplace safety and health program meeting the requirements of The Workplace Safety and Health Act (Manitoba), by providing:

(a) a valid COR certification number under the Certificate of Recognition (COR) Program - Option 1 administered by the Manitoba Heavy Construction Association's Safety, Health and Environment Program; or

(b) a valid COR certification number under the Certificate of Recognition (COR) Program administered by the Manitoba Construction Safety Association; or

(c) a report or letter to that effect from an independent reviewer acceptable to the City. (A list of acceptable reviewers and the review template are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.)

B10.3 The Bidder shall be prepared to submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B10.4 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

B11. BID SECURITY

B11.1 The Bidder shall provide bid security in the form of:

(a) a bid bond, in the amount of at least ten percent (10%) of the Total Bid Price, and agreement to bond of a company registered to conduct the business of a surety in Manitoba, in the form included in the Bid Submission (Form G1: Bid Bond and Agreement to Bond); or

(b) an irrevocable standby letter of credit, in the amount of at least ten percent (10%) of the Total Bid Price, and undertaking issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form included in the Bid Submission (Form G2: Irrevocable Standby Letter of Credit and Undertaking); or

(c) a certified cheque or draft payable to "The City of Winnipeg", in the amount of at least fifty percent (50%) of the Total Bid Price, drawn on a bank or other financial institution registered to conduct business in Manitoba.

B11.1.1 If the Bidder submits alternative bids, the bid security shall be in the amount of the specified percentage of the highest Total Bid Price submitted.

B11.2 The bid security of the successful Bidder and the next two lowest evaluated responsive and responsible Bidders will be released by the City when a Contract for the Work has been duly executed by the successful Bidder and the performance security furnished as provided herein. The bid securities of all other Bidders will be released when a Contract is awarded.

B11.2.1 Where the bid security provided by the successful Bidder is in the form of a certified cheque or draft pursuant to B11.1(c), it will be deposited and retained by the City as the performance security and no further submission is required.

B11.2.2 The City will not pay any interest on certified cheques or drafts furnished as bid security or subsequently retained as performance security.

B11.3 The bid securities of all Bidders will be released by the City as soon as practicable following notification by the Contract Administrator to the Bidders that no award of Contract will be made pursuant to the Bid Opportunity.

B12. OPENING OF BIDS AND RELEASE OF INFORMATION

B12.1 Bid Submissions will be opened publicly, after the Submission Deadline has elapsed, in the office of the Corporate Finance Department, Materials Management Branch, or in such other office as may be designated by the Manager of Materials.

B12.1.1 Bidders or their representatives may attend.

B12.1.2 Bid Submissions determined by the Manager of Materials, or his designate, to not include the bid security specified in B11 will not be read out.

B12.2 After the public opening, the names of the Bidders and their Total Bid Prices as read out (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

B12.3 After award of Contract, the name(s) of the successful Bidder(s) and the Contract Amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

B12.4 The Bidder is advised that any information contained in any Bid Submission may be released if required by City policy or procedures, by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law.

B13. IRREVOCABLE BID

B13.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 11 of Form A: Bid.

B13.2 The acceptance by the City of any Bid shall not release the Bids of the next two lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work until a Contract for the Work has been duly executed and the performance security furnished as herein provided, but any Bid shall be deemed to have lapsed unless accepted within the time period specified in Paragraph 11 of Form A: Bid.

B14. WITHDRAWAL OF BIDS

B14.1 A Bidder may withdraw his Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B14.1.1 Notwithstanding GC:23.3, the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.

B14.1.2 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid, and only such person, has authority to give notice of withdrawal.

B14.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials shall:

(a) retain the Bid Submission until after the Submission Deadline has elapsed;

(b) open the Bid Submission to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 12 of Form A: Bid; and

(c) if the notice has been given by any one of the persons specified in B14.1.3(b), declare the Bid withdrawn.

B14.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B13.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law, including the right to retain the Bidder's bid security.

B15. EVALUATION OF BIDS

B15.1 Award of the Contract shall be based on the following bid evaluation criteria:

(a) compliance by the Bidder with the requirements of the Bid Opportunity (pass/fail);

(b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B10 (pass/fail);

(c) Total Bid Price;

(d) economic analysis of any approved alternative pursuant to B6.

B15.2 Further to B15.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements if the interests of the City so require.

B15.3 Further to B15.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his Bid Submission or in other information required to be submitted, that he is responsible and qualified.

B15.4 Further to B15.1(c), for Alternative 1 and Alternative 2 the Total Bid Price shall be the sum of the quantities multiplied by the unit prices for each item shown on Form B: Prices.

B15.4.1 If there is any discrepancy between the Total Bid Price written in figures, the Total Bid Price written in words and the sum of the quantities multiplied by the unit prices for each item, the sum of the quantities multiplied by the unit prices for each item shall take precedence.

B15.5 The Contract may be awarded as a whole (Alternative 1) or separately by parts (Alternative 2) as identified on Form B: Prices.

B15.5.1 Notwithstanding B8.1, the Bidder may, but is not required to bid on any one or more parts of Alternative 2.

B15.5.2 The City shall have the right to choose the alternative that is in its best interests. If the Bidder has not bid on all alternatives, he shall have no claim against the City if his partial Bid is rejected in favour of an award of the Contract on the basis of an alternative or a part upon which he has not bid.

B16. AWARD OF CONTRACT

B16.1 The City will give notice of the award of the Contract by way of a letter of intent, or will give notice that no award will be made.

B16.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.

B16.2.1 Without limiting the generality of B16.2, the City will have no obligation to award a Contract where:

(a) the prices exceed the available City funds for the Work;

(b) the prices are materially in excess of the prices received for similar work in the past;

(c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;

(d) only one Bid is received; or

(e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B16.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid.

PART C - GENERAL CONDITIONS

C1. GENERAL CONDITIONS

C1.1 The *General Conditions for Construction Contracts* (Revision 2000 11 09) are applicable to the Work of the Contract.

C1.1.1 The *General Conditions for Construction Contracts* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

PART D - SUPPLEMENTAL CONDITIONS

GENERAL

D1. GENERAL CONDITIONS

D1.1 In addition to the *General Conditions for Construction Contracts*, these Supplemental Conditions are applicable to the Work of the Contract.

D1.2 The General Conditions are amended by striking out "The City of Winnipeg Act" wherever it appears in the General Conditions and substituting "The City of Winnipeg Charter".

D1.3 The General Conditions are amended by striking out "Tender Package" wherever it appears in the General Conditions and substituting "Bid Opportunity".

D1.4 The General Conditions are amended by striking out "Tender Submission" wherever it appears in the General Conditions and substituting "Bid Submission".

D1.5 The General Conditions are amended by deleting GC:6.16 and GC:6.17. The City of Winnipeg is now within the jurisdiction of the Manitoba Ombudsman pursuant to The Ombudsman Act.

D2. SCOPE OF WORK

General

D2.1 The Work to be done under the Contract shall consist of the supply and installation of mechanical and electrical systems in accordance with the Drawings and Specifications.

D2.1.1 If the Contract is awarded pursuant to Alternative 1 – Award as a Whole, the Contractor shall perform the Work of both Parts hereinafter described.

D2.1.2 If Contracts are awarded pursuant to Alternative 2 – Award by Parts, each Contractor (referred to as the Mechanical Contractor and the Electrical Contractor only for the purposes of clarity in D2.2 and D2.3) shall perform the Work of the Part awarded to him.

D2.1.3 The responsibility for proper operation of mechanical equipment shall remain with the Contractor who performs the mechanical installation of the equipment, regardless of who provides control or power wiring.

Part 1 - Mechanical

D2.2 The major components of Part 1 of the Work are as follows:

(a) Install the following City Supplied Equipment in accordance with the Supply Contractor's installation instructions (except as identified in D2.3):
   (i) DAF equipment (Bid Opportunity 154-2005);
   (ii) Four (4) raw water pumps, motors and VSDs (Bid Opportunity 515-2005);
   (iii) Ozone equipment (Bid Opportunity 428-2005);
   (iv) Filter troughs and underdrains (Bid Opportunity 427-2005);
   (v) Fourteen (14) water treatment plant sluice gates and three (3) flap gates (Bid Opportunity 561-2005);
   (vi) Five (5) 1350 mm butterfly valves and actuators (Bid Opportunity 731-2005).

(b) Perform all relevant portions of the Work as specified in Part E - Specifications and Division 01 including (but not limited to):
   (i) Supply and/or install concrete embeds and sleeves as specified in E8.

(ii) Provide the Performance Verification for all equipment supplied and installed under this Contract and Performance Verification support to Supply Contractors for all City Supplied Equipment installed under this Contract.

(iii) Following the completion of Form 103 for all equipment installed under this Contract, including City Supplied Equipment, provide commissioning assistance to the Contract Administrator during the Commissioning Period. This assistance shall be provided at the Contract Administrator's request.

(iv) Provide training to City personnel during the Commissioning Period and Warranty Period as specified.

(c) Perform all portions of the Work as specified in Divisions 05, 09, 11,13, 14 and 15 including (but not limited to):

(i) Unloading and providing care and custody from delivery until Total Performance (in accordance with the Supply Contractor's instructions) of the City Supplied Equipment specified in D2.2(a).

(ii) Pick up (at the City Warehouse), load, deliver to Site and install all City Supplied Equipment except for items specified in D2.3, which shall be installed by the Electrical Contractor.

(iii) Cleaning of all piping installed under this Contract, including piping that is supplied with City Supplied Equipment, in accordance with the technical specifications and in accordance with Supply Contactor's instructions. This includes on-site pickling and passivation.

(iv) Supply and installation of fire suppression system and fire detection system including wiring for the fire detection system. The conduit for the fire detection system shall be supplied and installed by the Electrical Contractor.

(v) Supply and installation of the HVAC control system (Building Automation System) for equipment supplied under Division 15 and as specified in 15900, 15901 and 15902 (unless otherwise specified) including the supply and installation of all HVAC control system wiring 50V or lower for the control of HVAC equipment.

(vi) Supply and install all disconnects for mechanical equipment which contains multiple motors including all air handling units (AHUs), make-up air unit (MAUs), heat recovery units (HRUs) and heat pumps (HPs).

(vii) Installation of all motors and mechanical VSDs on electrically driven mechanical equipment installed under these Divisions.

(viii) Supply and installation of HVAC system control wiring above 50V from the control system component requiring such wiring to a junction box located within 3m of the control system component. This junction box and all branch circuit wiring from the WTP electrical distribution to this junction box will be supplied and installed by the Electrical Contractor. The Mechanical Contractor shall advise the Electrical Contractor of the required location for this junction box. Termination within the junction box and Performance Verification for the HVAC control system shall be by the Mechanical Contractor.

(ix) Interface between the HVAC control system and the SCADA system and fire alarm system.

(x) Installation and mounting of all I&C equipment shown on the Drawings as being mounted in process piping systems including sensing elements, valves, actuators and other I&C accessories. This includes pipe mounted I&C equipment supplied with City Supplied Equipment and flange mounted I&C equipment supplied by the Electrical Contractor. The Mechanical Contractor shall supply and install all weldolets, threadolets, or other hardware required to mount I&C equipment to piping systems and shall supply and install all isolation valves required to isolate I&C equipment.

(xi) Supply and installation of instrument air piping larger than 12mm in diameter.

(xii) Application of all pipe coatings and touch up of all coatings on piping installed by him prior to Total Performance including touch up coatings for City Supplied Equipment using coatings supplied by the Supply Contractor.

(xiii) Supply and install all metal platforms, steel stairs, pipe supports, monorails and cranes as specified.

Part 2 - Electrical

D2.3 The major components of Part 2 of the Work are as follows:

(a) Perform all relevant portions of the Work as specified in Part E - Specifications and Division 01 including (but not limited to):

(i) Supply and/or install concrete embeds and sleeves as specified in E8.

(ii) Provide the Performance Verification for all equipment supplied and installed under this Contract and Performance Verification support to Supply Contractors for all City Supplied Equipment installed under this Contract.

(iii) Following the completion of Form 103 for all equipment installed under this Contract, including City Supplied Equipment, provide commissioning assistance to the Contract Administrator during the Commissioning Period. This assistance shall be provided at the Contract Administrator's request.

(iv) Provide training to City personnel during the Commissioning Period and Warranty Period as specified.

(b) Supply and installation of all portions of the Work as specified in Divisions 16 and 17 including (but not limited to):

(i) Supply and installation of HVAC system control wiring above 50V from the WTP electrical distribution to a junction box, supplied and installed by the Electrical Contractor within 3m of the control system component requiring such wiring. The Mechanical Contractor will advise the Electrical Contractor of the required location for this junction box. Termination within the junction box and Performance Verification for the HVAC control system shall be by the Mechanical Contractor.

(ii) Supply and installation of instrument air piping (12mm diameter and smaller), power, instrumentation and control wiring (regardless of voltage) to all equipment supplied pursuant to any Division of the Specifications and for all City Supplied Equipment, unless otherwise specified.

(iii) Termination of all wiring and instrument air tubing, performing all loop checks and the calibration of all process instrumentation and controls, regardless of voltage and regardless of whether the equipment is supplied and installed by the Electrical Contractor, supplied by the Electrical Contractor and installed pursuant to D2.2(c)(x) or is City Supplied Equipment.

(iv) For City Supplied Equipment, install all VFDs, PLCs, panels, power supplies and other equipment specified in Divisions 16 and 17 of the City Supplied Equipment contracts and identified as field installed on the Supply Contractor's shop drawings, unless otherwise specified in the Contract Documents.

(v) For City Supplied Equipment, supply and install all disconnects, stand alone motor starters, power and control wiring identified as "field wiring" (or similar wording) on the Supply Contractor's shop drawings as not being supplied and installed by the Supply Contractor.

(vi) For mechanical equipment supplied as specified in D2.2(c), supply and install all VFDs, starters mounted in MCCs and stand alone motor starters and disconnect switches (except as specified in D2.2(c)(vi)).

(vii) Lighting, emergency lighting, fire alarm and detection system (conduit only), and communication systems.

(c) Supply switchgear SWGR2A and SWGR 2B and power transformers XFMR-H965A and XFMR-H965B to the City for installation by others:

(i) The Electrical Contractor shall supply this equipment into the custody of an Installation Contractor and shall complete Forms 100, 101, 102 and 103 for this equipment, signing these forms as the Manufacturer. The installation of this equipment will be completed prior to Substantial Performance.

(ii) The Electrical Contractor shall provide all required training of the Installation Contractor and Performance Verification services as required to complete Forms 100, 101, 102 and 103 including providing the services of a Manufacturer's Representative where required. Performance Verification shall include all transformer and switchgear testing specified in Section 16030.

(iii) The Electrical Contractor shall provide all training during the Commissioning Period.

D2.4 The City will apply and pay for the Building Permit. All other permits are the Contractor's responsibility.

D3. DEFINITIONS

D3.1 When used in this Bid Opportunity:

(a) **Business Day** means any Calendar Day, other than a Saturday, Sunday, or a Statutory or Civic Holiday;

(b) **Submission Deadline** and **Time and Date Set for the Final Receipt of Bids** mean the time and date set out in the Bidding Procedures for final receipt of Bids;

(c) **Supply Contractor** means a contractor retained by the City, under a separate contract, to supply City Supplied Equipment which shall be installed by the Contractor;

(d) **Installation Contractor and/or Installer** means a contractor retained by the City, under a separate contract, to install certain pieces of equipment supplied under this contract

(e) **City Supplied Equipment** means equipment purchased by the City under a separate contract which is supplied into the care of the Contractor for installation under this Contract.

(f) **Substantial Performance** shall have the meaning attributed to it in the Builders' Liens Act (Manitoba), or any successor legislation thereto.

(g) **ANSI** means American National Standards Institute

(h) **ASME** means American Society of Mechanical Engineers

(i) **ASTM** means American Society for Testing and Materials

(j) **AWWA** means American Water Works Association

(k) **CAT 5** means category 5

(l) **CAT 5e** means category 5e (enhanced)

(m) **CETL (cETL, c-ETL)** means Testing Laboratories Inc.

(n) **CSA** means Canadian Standards Association

(o) **DAF** means Dissolved Air Flotation

(p) **ETL** means Electronic Testing Laboratories

(q) **IEC** means International Electrotechnical Commission

(r) **ISO** means International Organization for Standardization

(s) **NACE** means National Association of Corrosion Engineers

(t) **NEMA** means National Electrical Manufacturers Association

(u) **NSF** means National Sanitation Foundation

(v) **SAE** means Society of Automotive Engineers

(w) **Manufacturer** means the person, partnership or corporation responsible for the manufacture and fabrication of equipment supplied by the Contractor for the completion of the Work.

(x) **Manufacturer's Representative** means a trained serviceman empowered by the Manufacturer to provide installation, testing, and commissioning assistance to the Contractor in his performance of those functions.

(y) **IEEE** means Institute of Electrical and Electronics Engineers

(z) **NEMA** means National Electrical Manufacturer's Association

(aa) **Furnish** means supply

(bb) **ISA** means the Instrumentation Systems and Automation Society

(cc) **Total Performance** means that the entire Work, except those items arising from the Provision of GC.10.01 have been performed in accordance with this Contract

(dd) **AGMA** means American Gear Manufacturer's Association.

(ee) **API** means American Petroleum Institute

(ff) **EEMAC** means Electrical and Electronic Manufacturer Association of Canada

(gg) **VFD** means variable frequency drive

(hh) **VSD** means variable speed drive

(ii) **TPSH** means twisted pair shielded cable

(jj) **RTD** means resistance temperature detector

(kk) **LOX** means liquid oxygen

(ll) **GOX** means gaseous oxygen

(mm) **RWPS** means Raw Water Pumping Station

(nn) **DBPS** means Deacon Booster Pumping Station

(oo) **Contract Work Schedule** means a Gantt Charter developed by the Contractor developed using the critical path method which shows the proposed progress of the major items of work which are to be performed under this Contract

(pp) **Project Master Schedule** means a schedule developed by the Contract Administrator which includes and coordinates the Contract Work Schedules of several City contracts, including this Contract

(qq) **Professional Engineer** means a professional engineer registered in the Province of Manitoba.

(rr) **Major Equipment** means all equipment for which Shop Drawing submittals are required as specified herein.

(ss) **Performance Verification** means all factory and field tests, demonstrations and other activities required from the Contractor to complete all required Forms 103 – Certificate of Satisfactory Performance and to demonstrate to the Contract Administrator's satisfaction that the equipment installed under this Contract is performing as specified herein.

(tt) **Certified Shop Drawings** means Shop Drawings prepared by the Contractor after all required Shop Drawings have been "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity and which incorporate all modifications to the Shop Drawings, comments and notations made by the Contract Administrator in the course of the review.

(uu) **Acceptable Shop Drawings** means all required Shop Drawings have been reviewed by the Contract Administrator and have been annotated and stamped as "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity.

(vv) **Process Unit** means a complete equipment package supplied either by the Contractor or as part of City Supplied Equipment and which includes individual process components, skid mounted equipment and any related appurtenances.

(ww) **Control System Integrator** means a contractor retained by the City (under a different contract) to program and configure the water treatment plant SCADA system.

(xx) **Systems Integrator** means Control Systems Integrator.

(yy) **SCADA** means supervisor control and data acquisition.

(zz) **TGS** means Manitoba Transportation and Government Service.

(aaa) **MV** means medium voltage**.**

(bbb) **WTP** means the Winnipeg Water Treatment Plant and includes the structure and all equipment and materials supplied and installed into the building, under multiple construction contracts, including portions of the Work provided under this Contract.

(ccc) **City Warehouse** means the enclosed and heated City owned warehouse located at 1500 Plessis Road, Winnipeg, Manitoba.

(ddd) **Commissioning Period** means the time between the completion of Performance Verification and Total Performance during which a system is operated under Commissioning Operations Agent's control to demonstrate to the City it that it operates in conformance with the design intent

(eee) **Commissioning Operations Agent** means a qualified maintenance/operations team that takes primary responsibility for operation and maintenance of the WTP during the System Demonstration Period

(fff) **Certified Shop Drawings** means Shop Drawings prepared by the Contractor after all required Shop Drawings have been "reviewed" or "reviewed as modified" in accordance with Section 01300 of this Bid Opportunity and which incorporate all modifications to the Shop Drawings, comments and notations made by the Contract Administrator in the course of the review.

(ggg) **Record Drawings** means a minimum of one (1) complete set of Contract Documents and Certified Shop Drawings maintained at the Contractor's Site office on which the Contractor clearly shall clearly record in red pencil all Addenda, Change Orders, Field Instructions, and other revisions or as-built conditions which deviate from the original Contract Documents or Certified Shop Drawings.

(hhh) **O&M** means operation and maintenance

(iii) **I&C** means instrumentation and control

(jjj) **AASHTO** means American Association of State Highway and Transportation Officials

(kkk) **UV** means ultraviolet

(lll) **PVC** means polyvinyl chloride

(mmm) **ULC** means Underwriter's Laboratories of Canada

(nnn) **ASHRAE** means American Society of Heating, Refrigerating, and Air Conditioning Engineers

(ooo) **AWS** means American Welding Society

(ppp) **NFPA** means National Fire Protection Association

(qqq) **OSHA** means Occupational Safety and Health Act

(rrr) **FS** means Federal Specifications

(sss) **AFBMA** means Anti-Friction Bearing Manufacturer's Association

(ttt) **NACE** means National Association of Corrosion Engineers

(uuu) **PLC** means programmable logic controller

(vvv) **I/O** means input/output

(www) **UHMWPE** means ultra high molecular weight polyethylene

(xxx) **NPSH** means net positive suction head

(yyy) **NPSHR** means net positive suction head required

(zzz) **TEFC** means totally enclosed fan-cooled

(aaaa) **ABMA** means American Bearing Manufacturer's Association

(bbbb) **BEP** means best efficiency point

(cccc) **PTC** means positive thermal protection

(dddd) **ODP** means open drip proof

(eeee) **CEMA** means Canadian Electrical Manufacturer's Association

(ffff) **TDH** means total dynamic head

(gggg) **SSPC** means Steel Structures Painting Council

(hhhh) **P&ID** means process and instrumentation diagram

(iiii) **ILD** means instrument loop diagram

(jjjj) **HMI** means human machine interface

(kkkk) **UPS** means uninterruptible power supply

(llll) **MCC** means motor control centre

(mmmm) **Vendor Package** means a manufactured equipment package supplied and installed by the Contractor.

(nnnn) **Supplemental Training** means training provided by qualified Manufacturers' Representatives during the Warranty Period.

D3.2 The definitions of technical terms, abbreviations, and symbols will be those of the American Society for Testing and Materials, Canadian Standards Association and the applicable Codes and Standards. In the event of a dispute, the Contract Administrator's decision will be final.

D3.3 The Manufacturer and Manufacturer's Representative are not parties to this Contract. All work required from the Manufacturer and Manufacturer's Representative shall be provided and coordinated by the Contractor.

D3.4 Specialized terms relating to instrumentation and control and which are not explicitly defined herein shall be as defined in The Instrumentation Systems and Automation Society (ISA) S51.1, National Electrical Manufacturer's Association (NEMA) Industrial Control and Systems (ICS) 1, American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) Std 100, and the Communications Standard Dictionary, by Martin H. Weik.

D4. CONTRACT ADMINISTRATOR

D4.1 The Contract Administrator is UMA Projects (CM) Ltd., represented by:

Bill Richert, P. Eng.
1479 Buffalo Place
Winnipeg, MB
R3T 1L7

e-mail: bill.richert@uma.aecom.com

Telephone No. (204) 986-6053
Facsimile No. (204) 986-8393

D4.2 At the pre-construction meeting, the Contract Administrator will identify additional personnel representing the Contract Administrator and their respective roles and responsibilities for the Work.

D5. CONTRACTOR'S SUPERVISOR

D5.1 At the pre-construction meeting, the Contractor shall identify his designated supervisor and any additional personnel representing the Contractor and their respective roles and responsibilities for the Work.

D6. NOTICES

D6.1 Except as provided for in GC:23.2.2, all notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the Contractor shall be sent to the address or facsimile number identified by the Contractor in Paragraph 2 of Form A: Bid.

D6.2 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D6.3, D6.4 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the address or facsimile number identified in D4.1.

D6.3 All notices of appeal to the Chief Administrative Officer shall be sent to the following address or facsimile number:

The City of Winnipeg
Chief Administrative Officer Secretariat
Administration Building, 3rd Floor
510 Main Street
Winnipeg MB R3B 1B9

Facsimile No.: (204) 949-1174

D6.4 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following address or facsimile number:

The City of Winnipeg
Corporate Services Department
Legal Services Division
185 King Street, 3rd Floor
Winnipeg, MB R3B 1J1

Facsimile No.: (204) 947-9155

D7. FURNISHING OF DOCUMENTS

D7.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Bid Opportunity. If the Contractor requires additional sets of the Bid Opportunity, they will be supplied to him at cost.

SUBMISSIONS

D8. SAFE WORK PLAN

D8.1 The Contractor shall provide the Contract Administrator with a Safe Work Plan at least five (5) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.

D8.2 The Safe Work Plan should be prepared and submitted in the format shown in the City's template which is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

D9. INSURANCE

D9.1 The City will provide and maintain the following Project Insurance Coverages:

(a) Builder's Risk Insurance in the amount of one hundred percent (100%) of the total project cost.

(i) The Contractor shall be responsible for deductibles up to $10,000.00 maximum of any one loss.

(b) Wrap-Up Liability Insurance in an amount of no less than 10 million dollars ($10,000,000.00)

(i) The Contractor shall be responsible for deductibles up to $10,000.00 maximum of any one loss.

(c) The City of Winnipeg will carry such insurance to cover all parties engaged in the Work in this Contract. Provision of this insurance by the City of Winnipeg is not intended in any way to relieve the Contractor from his obligations under the terms of the Contract. Specifically, losses relating to deductibles for insurance, as well as losses in excess of limits of coverage and any risk of loss that is not covered under the terms of the insurance provided by the City of Winnipeg remains with the Contractor.

D9.2 The Contractor shall provide and maintain the following insurance coverage at all times during the performance of the Work:

(a) Automobile liability insurance for owned and non-owned automobiles used for or in connection with the work in the amount of at least two million dollars ($2,000,000.00).

(i) Deductibles shall be borne by the Contractor;

(ii) The Contractor shall not cancel, materially alter, or cause the policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator;

(iii) The Contractor shall provide the Contract Administrator with evidence of insurance of the policy at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than seven (7) Calendar Days from notification of the award of Contract.

D9.3 The Contractor shall not cancel, materially alter, or cause each policy to lapse without providing at least fifteen (15) Calendar Days prior written notice to the Contract Administrator.

D10. PERFORMANCE SECURITY

D10.1 The Contractor shall provide and maintain performance security until the expiration of the warranty period in the form of:

(a) a performance bond of a company registered to conduct the business of a surety in Manitoba, in the form attached to these Supplemental Conditions (Form H1: Performance Bond), in the amount of fifty percent (50%) of the Contract Price; or

(b) an irrevocable standby letter of credit issued by a bank or other financial institution registered to conduct business in Manitoba and drawn on a branch located in Winnipeg, in the form attached to these Supplemental Conditions (Form H2: Irrevocable Standby Letter of Credit), in the amount of fifty percent (50%) of the Contract Price; or

(c) a certified cheque or draft payable to "The City of Winnipeg", drawn on a bank or other financial institution registered to conduct business in Manitoba, in the amount of fifty percent (50%) of the Contract Price.

D10.1.1 Where the performance security is in the form of a certified cheque or draft, it will be deposited by the City. The City will not pay any interest on certified cheques or drafts furnished as performance security.

D10.2 If the bid security provided in his Bid Submission was not a certified cheque or draft pursuant to B11.1(c), the Contractor shall provide the City Solicitor with the required performance security within seven (7) Calendar Days of notification of the award of the Contract by way of letter of intent and prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.

D11. DETAILED PRICES

D11.1.1 The Contractor shall provide the Contract Administrator with a detailed price breakdown in a format acceptable to the Contract Administrator at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.

D12. SUBCONTRACTOR LIST

D12.1 The Contractor shall provide the Contract Administrator with a complete list of the Subcontractors whom the Contractor proposes to engage (Form J: Subcontractor List) at least two (2) Business Days prior to the commencement of any Work on the Site but in no event later than the date specified in GC:4.1 for the return of the executed Contract.

D13. DETAILED WORK SCHEDULE

D13.1 The Contract Administrator has developed a Project Master Schedule for the project. This schedule will be available in the offices of the Contract Administrator and will be updated as required as the work progresses.

D13.2 The Contractor shall, within 5 business days of award of contract, prepare a detailed Contract Work Schedule for his work based on a critical path method (CPM) approach.

D13.3 The schedule shall conform to the Project Master Schedule and show, in a clear graphical manner, through the use of Gantt charts, in a maximum of weekly stages, the proposed progress of the main items, structures and subtrades of the contract and indicate the labour, construction crews, plant and equipment to be employed. Indicate the delivery date of major pieces of equipment to be supplied. The schedule shall be predicated on the completion of all work on or before the date of Substantial Performance.

D13.4 Upon acceptance by the Contract Administrator, distribute copies of the revised schedule to Subcontractors and other concerned parties.

D13.5 The Contract Work Schedule shall be updated as the work requires and submitted to the Contract Administrator.

D13.6 The Contractor shall instruct recipients to report to the Contractor immediately any problems anticipated by the timetable shown in the Contract Work Schedule.

D13.7 While it is intended that the Contractor shall be allowed, in general, to carry on the Contract in accordance with such general plans as may appear to him to be most desirable, the Contract Administrator, at his discretion, may direct the order in which, and points at which, the work shall be undertaken.

D13.8 This control shall be exercised in the interests of the City so that the work or other Contractors who may be working on the site may be coordinated with the work on this Contract. A program of work will be drawn up and agreed to before the commencement of the Contract.

D13.9 The Contract Administrator shall be notified immediately when the work under the Contract Work Schedule will adversely affect the work of other Contractors and the critical path of the Project Master Schedule as the work under the Contractor's Contract Work Schedule is an integral part of the Project Master Schedule.

D13.10 The Contractor shall be familiar with all other Contract Work Schedules as contracted by the City with other Contractors and the critical path of the Project Master Schedule.

D14. SECURITY CLEARANCE

D14.1 Each individual proposed to perform Work on the Site shall be required to obtain a Criminal Record Check Search Certificate from the Police Service having jurisdiction at his place of residence.

D14.2 Prior to the commencement of any Work, and during the term of the Contract if additional or replacement individuals are proposed to perform Work, the Contractor shall supply the Contract Administrator with a Criminal Record Search Certificate obtained not earlier than one (1) year prior to the Submission Deadline, or a certified true copy thereof, for each individual proposed to perform Work within City facilities or on private property.

D14.3 Any individual for whom a Criminal Record Search Certificate is not provided, or for whom a Criminal Record Search Certificate indicates any convictions or pending charges related to property offences or crimes against another person, will not be permitted to perform any Work within City facilities or on private property.

D14.4 Any Criminal Record Search Certificate obtained thereby will be deemed valid for the duration of the Contract subject to a repeated records search as hereinafter specified.

D14.5 Notwithstanding the foregoing, at any time during the term of the Contract, the City may, at its sole discretion and acting reasonably, require an updated criminal records search. Any individual who fails to provide a satisfactory Criminal Record Search Certificate as a result of a repeated criminal records search will not be permitted to continue to perform Work under the Contract within City facilities or on private property.

D15. SHOP DRAWING SUBMITTAL LIST

D15.1 Within forty (40) Business Days notification of the Award of Contract by the way of Letter of Intent, the Contractor shall submit a complete list of all required submittals with specification Section numbers, description of item and estimated dates for submittals. This submittal list must be in electronic spreadsheet format in Microsoft Excel software.

D16. INSTRUMENTATION AND CONTROLS

D16.1 Within forty (40) Business Days of the notification of the Award of Contract by the way of Letter of Intent, the Contractor shall provide a list of products to be provided under Division 17 in accordance with clause 1.2.1 of Section 17010..

SCHEDULE OF WORK

D17. COMMENCEMENT

D17.1 The Contractor shall not commence any Work until he is in receipt of a letter of intent from the Award Authority authorizing the commencement of the Work.

D17.2 The Contractor shall not commence any Work on the Site until:

(a) the Contract Administrator has confirmed receipt and approval of:

(i) evidence that the Contractor is in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba;

(ii) evidence of the workers compensation coverage specified in GC:6.14;

(iii) the Safe Work Plan specified in D8;

(iv) evidence of the insurance specified in D9;

(v) the performance security specified in D10;

(vi) the detailed prices specified in D11;

(vii) the Subcontractor list specified in D12;

(viii) the detailed work schedule specified in D13; and

(ix) the security clearances specified in D14.

(b) the Contractor has attended a pre-construction meeting with the Contract Administrator, or the Contract Administrator has waived the requirement for a pre-construction meeting.

D17.3 The Contractor shall commence the Work on the Site within seven (7) Working Days of receipt of the letter of intent.

D18. CRITICAL STAGES

D18.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:

(a) Provide I&C panel Acceptable Shop Drawings for the System Integrator's use within 80 Business Days of the award of this Contract.

(b) September 8, 2006: Supply all embeds and sleeves to the concrete Installation Contractor.

(c) SWGR2A, SWGR 2B, XFMR-H965A and XFMR-H965B shall be supplied no earlier than December 1, 2007 and no later than December 22, 2007. The supply shall be considered complete upon the issuance of Form 100: Certificate of Satisfactory Delivery and Form 101: Certificate of Readiness to Install for each piece of equipment supplied.

(d) All electrical equipment specified to be installed in electrical room 1 (near the RWPS) shall be installed by August 31, 2007. Installation shall be considered complete when the equipment in electrical room 1 is energized and upon the issuance of Form 102: Certificate of Satisfactory Installation.

(e) All electrical equipment specified to be installed in electrical room 2 (near the Chemical Area) shall be installed by January 31, 2008. Installation shall be considered complete when the equipment in electrical room 2 is energized and upon the issuance of Form 102: Certificate of Satisfactory Installation.

(f) The Control Room shall be operational by March 31, 2008. The Control Room shall be considered operational upon the completion of the building mechanical and electrical support services as required for the City to install and operate their SCADA system.

(g) Satisfactory Training: Training for equipment installed under this Contract shall begin after the completion of Form 103: Certificate of Equipment Satisfactory Performance for all equipment installed under this Contract and prior to Total Performance. The detailed schedule for this training will be prepared and provided by the Contract Administrator upon completion of Form 103: Certificate of Equipment Satisfactory Performance for all equipment installed under this Contract. Training shall not be considered complete until Form T1 is completed for all equipment installed under this Contract.

D19. SUBSTANTIAL PERFORMANCE

D19.1 The Contractor shall achieve Substantial Performance by October 31, 2008.

D19.2 When the Contractor considers the Work to be substantially performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Substantial Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D19.3 The date on which the Work has been certified by the Contract Administrator as being substantially performed to the requirements of the Contract through the issue of a certificate of Substantial Performance is the date on which Substantial Performance has been achieved.

D19.4 Satisfactory Performance cannot be achieved without the completion of Form 103 Certificate of Equipment Satisfactory Performance for all equipment installed under this Contract.

D20. TOTAL PERFORMANCE

D20.1 The Contractor shall achieve Total Performance by December 31, 2008.

D20.2 When the Contractor or the Contract Administrator considers the Work to be totally performed, the Contractor shall arrange, attend and assist in the inspection of the Work with the Contract Administrator for purposes of verifying Total Performance. Any defects or deficiencies in the Work noted during that inspection shall be remedied by the Contractor at the earliest possible instance and the Contract Administrator notified so that the Work can be reinspected.

D20.3 The date on which the Work has been certified by the Contract Administrator as being totally performed to the requirements of the Contract through the issue of a certificate of Total Performance is the date on which Total Performance has been achieved.

D20.4 Total Performance cannot be achieved without the completion of Form T1: Certificate of Satisfactory Training for all equipment installed under this Contract.

D21. SUPPLEMENTAL TRAINING

D21.1 The City may, at its sole option, require the Contractor to provide Supplemental Training.

D21.1.1 Supplemental Training is intended to enable the City personnel to ask questions which may arise after Total Performance and after they have acquired several months experience with the equipment.

D21.1.2 The City may request a maximum of two (2) separate Supplemental Training sessions for any individual type of equipment supplied under this Contract. These sessions will be scheduled by the Contract Administrator to accommodate the schedules of City staff and may require separate trips to the Site by the Contractor.

D21.2 Supplemental Training shall be provided at the Site or at an alternate location in the City of Winnipeg as provided by the City.

D21.3 Payment for Supplemental Training shall be made in accordance with D27.

D21.4 Determination of Substantial Performance and Total Performance shall be exclusive of Supplemental Training identified herein. All Supplemental Training will be requested by the City and shall be completed prior to the expiration of the warranty period.

D22. LIQUIDATED DAMAGES

D22.1 If the Contractor fails to achieve Substantial Performance or Total Performance in accordance with the Contract by the days fixed herein for same, the Contractor shall pay the City the following amounts per Calendar Day for each and every Calendar Day following the days fixed herein for same during which such failure continues:

(a) Substantial Performance – two thousand, six hundred dollars ($2,600.00);

(b) Total Performance – six hundred dollars ($600).

D22.2 The amounts specified for liquidated damages in D22.1 is based on a genuine pre-estimate of the City's losses in the event that the Contractor does not achieve critical stages, Substantial Performance or Total Performance by the days fixed herein for same.

D22.3 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

D22.4 The City will not pay a bonus for performance if the Contractor reaches Substantial Performance or Total Performance earlier than the dates specified herein.

CONTROL OF WORK

D23. JOB MEETINGS

D23.1 Regular weekly job meetings will be held at the Site. These meetings shall be attended by a minimum of one representative of the Contract Administrator, one representative of the City and one representative of the Contractor. Each representative shall be a responsible person capable of expressing the position of the Contract Administrator, the City and the Contractor respectively on any matter discussed at the meeting including the Work schedule and the need to make any revisions to the Work schedule. The progress of the Work will be reviewed at each of these meetings.

D23.2 The Contract Administrator reserves the right to cancel any job meeting or call additional job meetings whenever he deems it necessary.

D24. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT (MANITOBA)

D24.1 Further to GC:6.26, UMA Projects (CM) Ltd. shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).

D24.2 As Prime Contractor, UMA Projects (CM) Ltd. will administer a Safety and Health Management Plan. Compliance with this Plan will be mandatory for all personnel on the construction site and orientation of all staff by the Prime Contractor's Safety Officer will be required. Further to GC:6.26, the Contractor shall be the Prime Contractor and shall serve as, and have the duties of the Prime Contractor in accordance with The Workplace Safety and Health Act (Manitoba).

D24.3 The Water Treatment Program Project Safety and Health Management Plan is available on the City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt/projects

D25. COOPERATION WITH OTHERS

D25.1 The Contractor shall note that several other construction contracts will be underway at the time of construction, including, but not limited to;

(a) Bid Opportunity 166-2005 Winnipeg Water Treatment Program – Clearwell Construction

(b) Bid Opportunity 650-2005 Winnipeg Water Treatment Program – Raw Water Pumping Station Construction

(c) Bid Opportunity 583-2005 Water Treatment Program - Water Treatment Plant Foundations and Concrete Structures

(d) Bid Opportunity 743-2005 Winnipeg Water Treatment Program – Water Treatment Plant Building Envelope

D25.2 Bid Opportunities for the above are available at the City of Winnipeg Materials Management website at http://www.winnipeg.ca/matmgt/bidopp.asp.

D25.3 The Contractor will not have exclusive use of the Site. The Contractor shall coordinate activities with others and minimize disruptions to others, where possible.

D25.4 Where site access requires relocation for installation of works, the Contractor shall construct suitable, all-weather detours, as required.

D25.5 The Contractor shall note that the Deacon Booster Pumping Station and surrounding compound will be in use during the construction period. The Contractor shall maintain reasonable access to all existing plant, valve chambers, rail, mechanical and electrical facilities at all times. The Contractor shall provide all reasonable assistance to Operations personnel to provide safe, secure access to operational facilities.

D26. PARTNERING

D26.1 In order to effectively and efficiently accomplish the Work of this Contract, The City of Winnipeg, Water and Waste Department is encouraging the formation of a cohesive, mutually beneficial working relationship with the Contractor, his Subcontractors and representatives from the successful bidder for Bid Opportunity 583-2005 Winnipeg Water Treatment Program – WTP Foundations and Concrete Structures as well as other contractors on site. This working relationship will endeavour to draw on individual and corporate and community strengths, skills and knowledge to achieve a quality project to the benefit of all participants. The objective of Partnering is to build co-operative relationships, avoid or minimize disputes and actively pursue the attainment of common goals. Success will depend upon teamwork with open and effective communication while adhering to the highest professional standards. Participation in Partnering will not in any way affect the application or legal obligation of the Contract. The Partnering Initiation Workshop is typically a two (2) day session for a project of this magnitude. The Partnering Initiation Workshop will be scheduled following award of this contract for a date in August 2006.

D26.2 Participation in the Partnering Initiation Workshop shall be carried out at no cost to the Contractor nor shall any payment be made for time and travel expenses incurred by the Contractor associated with participation in the Partnering Initiation Workshop. It shall be considered incidental to the Work included in this project.

MEASUREMENT AND PAYMENT

D27. PAYMENT SCHEDULE

D27.1 Further to GC:12, payment shall be in accordance with the following payment schedule:

(a) The unit price for item 1 listed in Form B: Prices will be paid on the basis of monthly progress estimates in accordance with GC:12 and the detailed price breakdown prepared pursuant to D11.

(b) One hundred thousand dollars ($100,000) of the unit price for item 1 in Form B: Prices will be paid upon satisfactory completion of Record Drawings.

(c) One hundred fifty thousand dollars ($150,000) of the unit price for item 1in Form B: Prices will be paid upon satisfactory completion of all required O&M manuals.

(d) The unit price for item 2 listed in Form B: Prices will be paid on the basis of time spent on Site. Timesheets shall be submitted by the Contractor and approved by the Contract Administrator. The unit prices in Form B: Prices shall be inclusive of all overhead (including small tool costs) and profit. No additional mark-up shall be applied to any labour performed by any Subcontractor during the Commissioning Period. Unless otherwise specified, all other costs associated with providing these services shall be incidental to the Work.

(e) Materials supplied by the Contractor, at the request of the Contract Administrator, during the Commissioning Period shall be valued in accordance with GC7.4(d).

(f) The unit price for item 3 listed in Form B: Prices will be paid upon the issuance of Form T1: Certificate of Satisfactory Training for all equipment installed under this Contract.

(g) The unit price for item 4 listed in Form B: Prices will be paid on the basis of time spent providing Supplemental Training on Site. Timesheets shall be submitted by the Contractor and approved by the Contract Administrator. Unless otherwise specified, all other costs associated with providing Supplemental Training shall be incidental to the Work.

WARRANTY

D28. WARRANTY

D28.1 Further to GC.10.01, if a defect or deficiency prevents the full and normal use or operation of the Work or any portion thereof, for purposes of calculating the warranty period, time shall be deemed to cease to elapse for the defective or deficient portion, and for any portion of the Work whose use or operation is prevented by such defect or deficiency, as of the date on which the defect or deficiency is observed or the use or operation is prevented and shall begin to run again when the defect or deficiency has been corrected or the Work may be used or operated to the satisfaction of the Contract Administrator.

D28.2 Notwithstanding GC.10.01, GC.10.02 and D28.1, if any law of Manitoba or of the jurisdiction in which the Work was manufactured requires, or if the manufacturer provides, a longer warranty period or a warranty which is more extensive in its nature, then the provisions of such law or manufacturer's warranty shall apply.

D28.3 Notwithstanding GC:13.2, the warranty period shall begin on the date of Total Performance and shall expire one (1) year thereafter, except where longer warranty periods are specified in the respective Specification sections, unless extended pursuant to GC:13.2.1 or GC:13.2.2, in which case it shall expire when provided for thereunder.

D28.3.1 For the purpose of Performance Security, the warranty period shall be one (1) year.

D28.4 Warranty for the installation of City Supplied Equipment is the responsibility of the Contractor. Warranty for the proper operation of properly installed City Supplied Equipment is the responsibility of the Supply Contractor.

FORM H1: PERFORMANCE BOND
(See D10)

KNOW ALL MEN BY THESE PRESENTS THAT

_____
(hereinafter called the "Principal"), and

_____ ,
(hereinafter called the "Surety"), are held and firmly bound unto **THE CITY OF WINNIPEG** (hereinafter called the "Obligee"), in the sum of

_____

_____ dollars ($_____.____)

of lawful money of Canada to be paid to the Obligee, or its successors or assigns, for the payment of which sum the Principal and the Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS the Principal has entered into a written contract with the Obligee dated the

_____ day of _____ , 20____ , for:

BID OPPORTUNITY NO. 742-2005

WINNIPEG WATER TREATMENT PROGRAM - SUPPLY AND INSTALLATION OF WATER TREATMENT PLANT PROCESS MECHANICAL & ELECTRICAL

which is by reference made part hereof and is hereinafter referred to as the “Contract”.

NOW THEREFORE the condition of the above obligation is such that if the Principal shall:

(a) carry out and perform the Contract and every part thereof in the manner and within the times set forth in the Contract and in accordance with the terms and conditions specified in the Contract;
(b) perform the Work in a good, proper, workmanlike manner;
(c) make all the payments whether to the Obligee or to others as therein provided;
(d) in every other respect comply with the conditions and perform the covenants contained in the Contract; and
(e) indemnify and save harmless the Obligee against and from all loss, costs, damages, claims, and demands of every description as set forth in the Contract, and from all penalties, assessments, claims, actions for loss, damages or compensation whether arising under "The Workers Compensation Act", or any other Act or otherwise arising out of or in any way connected with the performance or non-performance of the Contract or any part thereof during the term of the Contract and the warranty period provided for therein;

THEN THIS OBLIGATION SHALL BE VOID, but otherwise shall remain in full force and effect. The Surety shall not, however, be liable for a greater sum than the sum specified above.

AND IT IS HEREBY DECLARED AND AGREED that the Surety shall be liable as Principal, and that nothing of any kind or matter whatsoever that will not discharge the Principal shall operate as a discharge or release of liability of the Surety, any law or usage relating to the liability of Sureties to the contrary notwithstanding.

IN WITNESS WHEREOF the Principal and Surety have signed and sealed this bond the

_____ day of _____ , 20____ .

SIGNED AND SEALED
in the presence of:

_____
(Witness)

_____
(Name of Principal)

Per: _____ (Seal)

Per: _____

_____
(Name of Surety)

By: _____ (Seal)
(Attorney-in-Fact)

FORM H2: IRREVOCABLE STANDBY LETTER OF CREDIT
(PERFORMANCE SECURITY)
(See D10)

_____
(Date)

The City of Winnipeg
Corporate Services Department
Legal Services Division
185 King Street, 3rd Floor
Winnipeg MB R3B 1J1

RE: PERFORMANCE SECURITY - BID OPPORTUNITY NO. 742-2005

WINNIPEG WATER TREATMENT PROGRAM - SUPPLY AND INSTALLATION OF WATER TREATMENT PLANT PROCESS MECHANICAL & ELECTRICAL

Pursuant to the request of and for the account of our customer,

_____ ,
(Name of Contractor)

_____
(Address of Contractor)

WE HEREBY ESTABLISH in your favour our irrevocable Standby Letter of Credit for a sum not exceeding in the aggregate

_____

_____ Canadian dollars.

This Standby Letter of Credit may be drawn on by you at any time and from time to time upon written demand for payment made upon us by you. It is understood that we are obligated under this Standby Letter of Credit for the payment of monies only and we hereby agree that we shall honour your demand for payment without inquiring whether you have a right as between yourself and our customer to make such demand and without recognizing any claim of our customer or objection by the customer to payment by us.

The amount of this Standby Letter of Credit may be reduced from time to time only by amounts drawn upon it by you or by formal notice in writing given to us by you if you desire such reduction or are willing that it be made.

Partial drawings are permitted.

We engage with you that all demands for payment made within the terms and currency of this Standby Letter of Credit will be duly honoured if presented to us at:

_____
(Address)

and we confirm and hereby undertake to ensure that all demands for payment will be duly honoured by us.

All demands for payment shall specifically state that they are drawn under this Standby Letter of Credit.

Subject to the condition hereinafter set forth, this Standby Letter of Credit will expire on

_____ .
(Date)

It is a condition of this Standby Letter of Credit that it shall be deemed to be automatically extended from year to year without amendment from the present or any future expiry date, unless at least 30 days prior to the present or any future expiry date, we notify you in writing that we elect not to consider this Standby Letter of Credit to be renewable for any additional period.

This Standby Letter of Credit may not be revoked or amended without your prior written approval.

This credit is subject to the Uniform Customs and Practice for Documentary Credit (1993 Revision), International Chamber of Commerce Publication Number 500.

_____
(Name of bank or financial institution)

Per: _____
(Authorized Signing Officer)

Per: _____
(Authorized Signing Officer)

FORM J: SUBCONTRACTOR LIST
(See D12)

WINNIPEG WATER TREATMENT PROGRAM - SUPPLY AND INSTALLATION OF WATER TREATMENT PLANT PROCESS MECHANICAL & ELECTRICAL

Name	Address

PART E - SPECIFICATIONS

GENERAL

E1. APPLICABLE SPECIFICATIONS, STANDARD DETAILS AND DRAWINGS

E1.1 *The City of Winnipeg Standard Construction Specifications* in its entirety, whether or not specifically listed on Form B: Prices, shall apply to the Work.

E1.1.1 *The City of Winnipeg Standard Construction Specifications* is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt.

E1.1.2 The version in effect three (3) Business Days before the Submission Deadline shall apply.

E1.1.3 Further to GC:2.4(d), Specifications included in the Bid Opportunity shall govern over *The City of Winnipeg Standard Construction Specifications*.

E1.2 The following Drawings are applicable to the Work:

Consultant Drawing No.	City Drawing No.	Drawing Title
CM-G001		Construction Site Layout
WA-E0101	1-0601A-A-E0101-001-00D	Electrical - Administration Area - Lower Level Facility Plan
WA-E0102	1-0601A-A-E0102-001-00D	Electrical - Administration Area - Lower Level Process Plan
WA-E0103	1-0601A-A-E0103-001-00D	Electrical - Administration Area - Lower Level Power and Lighting Plan
WA-E0111	1-0601A-A-E0111-001-00D	Electrical - Administration Area - First Floor Facility Plan
WA-E0112	1-0601A-A-E0112-001-00D	Electrical - Administration Area - First Floor Process Plan
WA-E0113	1-0601A-A-E0113-001-00D	Electrical - Administration Area - First Floor Power and Lighting Plan
WA-E0121	1-0601A-A-E0121-001-00D	Electrical - Administration Area - Second Floor Facility Plan
WA-E0123	1-0601A-A-E0123-001-00D	Electrical - Administration Area - Second Floor Power and Lighting Plan
WA-E0131	1-0601A-A-E0131-001-00D	Electrical - Administration Area - Third Floor Facility Plan
WA-E0133	1-0601A-A-E0133-001-00D	Electrical - Administration Area - Third Floor Power and Lighting Plan
WA-E0145	1-0601A-A-E0145-001-00D	Electrical - Administration Area - Roof Facility Plan
WA-E0147	1-0601A-A-E0147-001-00D	Electrical - Administration Area - Roof Power and Lighting Plan
WA-E0201	1-0601A-A-E0201-001-00D	Electrical - Administration Area - Stair Lighting
WA-E0401	1-0601A-A-E0401-001-00D	Electrical - Administration Area - Second Floor Power and Lighting Plan
WA-E0402	1-0601A-A-E0402-001-00D	Electrical - Administration Area - Third Floor Power and Lighting Plan
WA-E0403	1-0601A-A-E0403-001-00D	Electrical - Administration Area - Third Floor Power and Lighting Plan
WA-H0102	1-0601A-A-H0102-001-00D	Plumbing - Administration Area - Lower Level Plan
WA-H0111	1-0601A-A-H0111-001-00D	HVAC - Administration Area - First Floor Plan
WA-H0112	1-0601A-A-H0112-001-00D	Plumbing - Administration Area - First Floor Plan
WA-H0121	1-0601A-A-H0121-001-00D	HVAC - Administration Area - Second Floor Plan
WA-H0122	1-0601A-A-H0122-001-00D	Plumbing - Administration Area - Second Floor Plan
WA-H0131	1-0601A-A-H0131-001-00D	HVAC - Administration Area and Mechanical Room No. 4 - Third Floor Plan
WA-H0132	1-0601A-A-H0132-001-00D	Plumbing - Administration Area - Third Floor Plan
WA-H0142	1-0601A-A-H0142-001-00D	Plumbing - Administration Area - Plan At Elevation 251.450
WA-H0146	1-0601A-A-H0146-001-00D	Plumbing - Administration Area - Roof Plan
WA-H9102	1-0601A-A-H9102-001-00D	Plumbing - Pipe Embeds - Administration Area Lower Level Plan
WA-H9122	1-0601A-A-H9122-001-00D	Plumbing - Pipe Embeds - Administration Area Second Floor Plan
WA-H9132	1-0601A-A-H9132-001-00D	Plumbing - Pipe Embeds - Administration Area Third Floor Plan
WB-A0401	1-0601B-D-A0401-001-00B	Automation / I & C - Ultrasonic Level Transducer - Installation Details
WB-A0402	1-0601B-D-A0402-001-00B	Automation / I & C - Loop Powered Remote Indicating Transmitter - Installation Details
WB-A0403	1-0601B-D-A0403-001-00B	Automation / I & C - Hand Switch Mounting - Installation Details

Consultant Drawing No.	City Drawing No.	Drawing Title
WB-A0404	1-0601B-D-A0404-001-00B	Automation / I & C - Pressure Guage - Installation Details
WB-A0405	1-0601B-D-A0405-001-00B	Automation / I & C - Pressure Switch - Installation Details
WB-A0406	1-0601B-D-A0406-001-00B	Automation / I & C - Float Switch - Installation Details
WB-A0407	1-0601B-D-A0407-001-00B	Automation / I & C - Thermowell Mounted RTD - Installation Details
WB-A0408	1-0601B-D-A0408-001-00B	Automation / I & C - Pressure Transmitter and In-line Pressure Sensor - Installation Details
WB-A0409	1-0601B-D-A0409-001-00B	Automation / I & C - Raw Water pH/Turbitity Analyzer - Installation Details
WB-A0410	1-0601B-D-A0410-001-00B	Automation / I & C - Turbitity / TSS Sensor - Installation Details
WB-A0451	1-0601B-H-A0451-001-00B	Automation / I & C - Typical Motorized Valve Open / Close - Instrumentation Loop Diagram
WB-A0452	1-0601B-H-A0452-001-00B	Automation / I & C - Typical Motorized Valve Modulating - Instrumentation Loop Diagram
WB-A0453	1-0601B-H-A0453-001-00B	Automation / I & C - Typical Magnetic Flow Meter - Instrumentation Loop Diagram
WB-A0454	1-0601B-H-A0454-001-00B	Automation / I & C - Typical Thermal Mass Flowmeter - Instrumentation Loop Diagram
WB-A0455	1-0601B-H-A0455-001-00B	Automation / I & C - Typical Ultrasonic Level Transmitter - Instrumentation Loop Diagram
WB-A0456	1-0601B-H-A0456-001-00B	Automation / I & C - Typical Thermal Dispersion Flow Meter - Instrumentation Loop Diagram
WB-A0457	1-0601B-H-A0457-001-00B	Automation / I & C - Typical Chlorine Residual Analyzer - Instrumentation Loop Diagram
WB-A0458	1-0601B-H-A0458-001-00B	Automation / I & C - Typical Conductivity Level Switch Single Point - Instrumentation Loop Diagram
WB-A0459	1-0601B-H-A0459-001-00B	Automation / I & C - Typical Turbitity Analyzer - Instrumentation Loop Diagram
WB-A0460	1-0601B-H-A0460-001-00B	Automation / I & C - Typical pH Analyzer - Instrumentation Loop Diagram
WB-A0461	1-0601B-H-A0461-001-00B	Automation / I & C - Typical MCC Starter - Instrumentation Loop Diagram
WB-A0462	1-0601B-H-A0462-001-00B	Automation / I & C - Typical Turbidity / TSS Analyzer - Instrumentation Loop Diagram
WB-A0463	1-0601B-H-A0463-001-00B	Automation / I & C - Typical Discrete Input - Instrumentation Loop Diagram
WB-A0464	1-0601B-H-A0464-001-00B	Automation / I & C - Typical Valve Limit Switch - Instrumentation Loop Diagram
WB-A0465	1-0601B-H-A0465-001-00B	Automation / I & C - Typical Loop Powered Analogue Input - Instrumentation Loop Diagram
WB-A0466	1-0601B-H-A0466-001-00B	Automation / I & C - Typical 3 Wire RTD - Instrumentation Loop Diagram
WB-E0100	1-0601B-A-E0100-001-00D	Electrical - Overall Building - Lower Level Plan
WB-E0110	1-0601B-A-E0110-001-00D	Electrical - Overall Building - First Floor Plan
WB-E0120	1-0601B-A-E0120-001-00D	Electrical - Overall Building - Second Floor Plan
WB-E0130	1-0601B-A-E0130-001-00D	Electrical - Overall Building - Third Floor Plan
WB-E0145	1-0601B-A-E0145-001-00D	Electrical - Overall Building - Roof Plan
WB-E0401	1-0601B-A-E0401-001-00D	Electrical - Details
WB-E0402	1-0601B-A-E0402-001-00D	Electrical - Details
WB-E0403	1-0601B-A-E0403-001-00D	Electrical - Details
WB-E0404	1-0601B-A-E0404-001-00D	Electrical - Details
WB-E0405	1-0601B-A-E0405-001-00D	Electrical - Details
WB-E0455	1-0601B-A-E0455-001-00D	Electrical - Standard Details
WB-E0456	1-0601B-A-E0456-001-00D	Electrical - Standard Details
WB-E0457	1-0601B-A-E0457-001-00D	Electrical - Standard Details
WB-E0458	1-0601B-A-E0458-001-00D	Electrical - Standard Details
WB-E0501	1-0601B-D-E0501-001-00D	Electrical - Luminaire Schedule
WB-E0502	1-0601B-D-E0502-001-00D	Electrical - General Circuit Conductor Identification Schedule
WB-E0503	1-0601B-E-E0503-001-00D	Electrical - Fire Alarm - Riser Diagram
WB-E0511	1-0601B-F-E0511-001-00D	Electrical - 600V Switchgear Single Line Diagram
WB-E0512	1-0601B-F-E0512-001-00D	Electrical - 600V Single Line Diagram
WB-E0513	1-0601B-F-E0513-001-00D	Electrical - 600V Single Line Diagram
WB-E0514	1-0601B-F-E0514-001-00D	Electrical - 600V Switchgear / MCC Layouts
WB-E0517	1-0601B-F-E0517-001-00D	Electrical - 600V Single Line Diagram
WB-E0518	1-0601B-F-E0518-001-00D	Electrical - 600V Switchgear / MCC Layouts
WB-E0519	1-0601B-F-E0519-001-00D	Electrical - 600V Single Line Diagram
WB-E0520	1-0601B-F-E0520-001-00D	Electrical - 600V Single Line Diagram
WB-E0525	1-0601B-D-E0525-001-00D	Electrical - Panel Schedule

Consultant Drawing No.	City Drawing No.	Drawing Title
WB-E0526	1-0601B-D-E0526-001-00D	Electrical - Panel Schedule
WB-E0527	1-0601B-D-E0527-001-00D	Electrical - Panel Schedule
WB-E0528	1-0601B-D-E0528-001-00D	Electrical - Panel Schedule
WB-E0529	1-0601B-D-E0529-001-00D	Electrical - Panel Schedule
WB-E0530	1-0601B-D-E0530-001-00D	Electrical - Panel Schedule
WB-E0531	1-0601B-D-E0531-001-00D	Electrical - Panel Schedule
WB-E0532	1-0601B-D-E0532-001-00D	Electrical - Panel Schedule
WB-E0533	1-0601B-D-E0533-001-00D	Electrical - Panel Schedule
WB-E0534	1-0601B-D-E0534-001-00D	Electrical - Panel Schedule
WB-E0535	1-0601B-D-E0535-001-00D	Electrical - Panel Schedule
WB-E0536	1-0601B-D-E0536-001-00D	Electrical - Panel Schedule
WB-E0537	1-0601B-D-E0537-001-00D	Electrical - Panel Schedule
WB-E0538	1-0601B-D-E0538-001-00D	Electrical - Panel Schedule
WB-E0539	1-0601B-D-E0539-001-00D	Electrical - Panel Schedule
WB-E0541	1-0601B-H-E0541-001-00D	Electrical - Control Diagram
WB-E0542	1-0601B-H-E0542-001-00D	Electrical - Control Diagram
WB-E0543	1-0601B-H-E0543-001-00D	Electrical - Control Diagram
WB-E0544	1-0601B-H-E0544-001-00D	Electrical - Control Diagram
WB-E0545	1-0601B-H-E0545-001-00D	Electrical - Control Diagram
WB-E0546	1-0601B-H-E0546-001-00D	Electrical - Control Diagram
WB-E0547	1-0601B-H-E0547-001-00D	Electrical - Control Diagram
WB-E0548	1-0601B-H-E0548-001-00D	Electrical - Control Diagram
WB-E0549	1-0601B-H-E0549-001-00D	Electrical - Control Diagram
WB-E0550	1-0601B-H-E0550-001-00D	Electrical - Control Diagram
WB-E0551	1-0601B-H-E0551-001-00D	Electrical - Control Diagram
WB-E0552	1-0601B-H-E0552-001-00D	Electrical - Control Diagram
WB-E0553	1-0601B-H-E0553-001-00D	Electrical - Control Diagram
WB-E0554	1-0601B-H-E0554-001-00D	Electrical - Control Diagram
WB-E0556	1-0601B-H-E0556-001-00D	Electrical - Control Diagram
WB-E0557	1-0601B-H-E0557-001-00D	Electrical - Control Diagram
WB-E0558	1-0601B-H-E0558-001-00D	Electrical - Control Diagram
WB-E0559	1-0601B-H-E0559-001-00D	Electrical - Control Diagram
WB-E0560	1-0601B-H-E0560-001-00D	Electrical - Control Diagram
WB-E0561	1-0601B-H-E0561-001-00D	Electrical - Control Diagram
WB-E0562	1-0601B-H-E0562-001-00D	Electrical - Control Diagram
WB-E0563	1-0601B-H-E0563-001-00D	Electrical - Control Diagram
WB-E0564	1-0601B-H-E0564-001-00D	Electrical - Control Diagram
WB-E0565	1-0601B-H-E0565-001-00D	Electrical - Control Diagram
WB-E0566	1-0601B-H-E0566-001-00D	Electrical - Control Diagram
WB-E0567	1-0601B-H-E0567-001-00D	Electrical - Control Diagram
WB-E0568	1-0601B-H-E0568-001-00D	Electrical - Control Diagram
WB-E0569	1-0601B-H-E0569-001-00D	Electrical - Control Diagram
WB-E0570	1-0601B-H-E0570-001-00D	Electrical - Control Diagram
WB-E0571	1-0601B-E-E0571-001-00D	Electrical - Cable Block Diagrams
WB-E0572	1-0601B-E-E0572-001-00D	Electrical - Cable Block Diagrams
WB-E0573	1-0601B-E-E0573-001-00D	Electrical - Cable Block Diagrams
WB-E0574	1-0601B-E-E0574-001-00D	Electrical - Cable Block Diagrams
WB-E0575	1-0601B-E-E0575-001-00D	Electrical - Cable Block Diagrams
WB-E0576	1-0601B-E-E0576-001-00D	Electrical - Cable Block Diagrams
WB-E0577	1-0601B-E-E0577-001-00D	Electrical - Cable Block Diagrams
WB-E0578	1-0601B-E-E0578-001-00D	Electrical - Cable Block Diagrams

Consultant Drawing No.	City Drawing No.	Drawing Title
WB-E0579	1-0601B-E-E0579-001-00D	Electrical - Cable Block Diagrams
WB-E0580	1-0601B-E-E0580-001-00D	Electrical - Cable Block Diagrams
WB-E0581	1-0601B-E-E0581-001-00D	Electrical - Cable Block Diagrams
WB-E0582	1-0601B-E-E0582-001-00D	Electrical - Cable Block Diagrams
WB-E0583	1-0601B-E-E0583-001-00D	Electrical - Cable Block Diagrams
WB-E0584	1-0601B-E-E0584-001-00D	Electrical - Cable Block Diagrams
WB-E0585	1-0601B-E-E0585-001-00D	Electrical - Cable Block Diagrams
WB-H0101	1-0601B-A-H0101-001-00D	Plumbing - Overall Building - Lower Level Key Plan
WB-H0102	1-0601B-A-H0102-001-00D	Fire Protection - Overall Building - Lower Level Plan
WB-H0110	1-0601B-A-H0110-001-00D	HVAC - Overall Building - First Floor Key Plan
WB-H0111	1-0601B-A-H0111-001-00D	Plumbing - Overall Building - First Floor Key Plan
WB-H0112	1-0601B-A-H0112-001-00D	Fire Protection - Overall Building - First Floor Plan
WB-H0120	1-0601B-A-H0120-001-00D	HVAC - Overall Building - Second Floor Key Plan
WB-H0121	1-0601B-A-H0121-001-00D	Plumbing - Overall Building - Second Floor Key Plan
WB-H0122	1-0601B-A-H0122-001-00D	Fire Protection - Overall Building - Second Floor Plan
WB-H0130	1-0601B-A-H0130-001-00D	HVAC - Overall Building - Third Floor Key Plan
WB-H0131	1-0601B-A-H0131-001-00D	Plumbing - Overall Building - Third Floor Key Plan
WB-H0132	1-0601B-A-H0132-001-00D	Fire Protection - Overall Building - Third Floor Plan
WB-H0145	1-0601B-A-H0145-001-00D	HVAC - Main Building - Roof Plan
WB-H0146	1-0601B-A-H0146-001-00D	Plumbing - Overall Building - Roof Key Plan
WB-H0451	1-0601B-A-H0451-001-00D	HVAC - Standard Details
WB-H0452	1-0601B-A-H0452-001-00D	HVAC - Standard Details
WB-H0453	1-0601B-A-H0453-001-00D	HVAC - Standard Details
WB-H0454	1-0601B-A-H0454-001-00D	HVAC - Standard Details
WB-H0455	1-0601B-A-H0455-001-00D	HVAC - Standard Details
WB-H0471	1-0601B-A-H0471-001-00D	Plumbing - Standard Details
WB-H0472	1-0601B-A-H0472-001-00D	Plumbing - Standard Details
WB-H0473	1-0601B-A-H0473-001-00D	Plumbing - Standard Details
WB-H0474	1-0601B-A-H0474-001-00D	Plumbing - Standard Details
WB-H0475	1-0601B-A-H0475-001-00D	Plumbing - Standard Details
WB-H0501	1-0601B-G-H0501-001-00D	HVAC - Schematic
WB-H0502	1-0601B-G-H0502-001-00D	HVAC - Schematic
WB-H0503	1-0601B-G-H0503-001-00D	HVAC - Schematic
WB-H0504	1-0601B-G-H0504-001-00D	HVAC - Schematic
WB-H0505	1-0601B-G-H0505-001-00D	HVAC - Schematic
WB-H0531	1-0601B-G-H0531-001-00D	Plumbing - Service Water Schematic - Sheet 1
WB-H0532	1-0601B-G-H0532-001-00D	Plumbing - Service Water Schematic - Sheet 2
WB-H0533	1-0601B-G-H0533-001-00D	Plumbing - Potable Water Schematic
WB-H0534	1-0601B-G-H0534-001-00D	Plumbing - Compressed Air Schematic
WB-H9101	1-0601B-A-H9101-001-00D	Plumbing - Pipe Embeds - Overall Lower Level Plan
WB-H9111	1-0601B-A-H9111-001-00D	Plumbing - Pipe Embeds - Overall First Floor Plan
WB-H9121	1-0601B-A-H9121-001-00D	Plumbing - Pipe Embeds - Overall Second Floor Plan
WB-H9131	1-0601B-A-H9131-001-00D	Plumbing - Pipe Embeds - Overall Third Floor Plan
WB-H9451	1-0601B-A-H9451-001-00D	Plumbing - Standard Details
WB-H9452	1-0601B-A-H9452-001-00D	Plumbing - Standard Details
WB-M0100	1-0601B-A-M0100-001-00D	Process Mechanical - Overall Building - Lower Level Key Plan
WB-M0110	1-0601B-A-M0110-001-00D	Process Mechanical - Overall Building - First Floor Key Plan
WB-M0120	1-0601B-A-M0120-001-00D	Process Mechanical - Overall Building - Second Floor Key Plan
WB-M0130	1-0601B-A-M0130-001-00D	Process Mechanical - Overall Building - Third Floor Key Plan
WB-M0145	1-0601B-A-M0145-001-00D	Process Mechanical - Overall Building - Roof Key Plan
WB-M0451	1-0601B-A-M0451-001-00D	Process Mechanical - Standard Details

Consultant Drawing No.	City Drawing No.	Drawing Title
WB-M0452	1-0601B-A-M0452-001-00D	Process Mechanical - Standard Details
WB-M0455	1-0601B-A-M0455-001-00D	Process Mechanical - Standard Details
WB-M0456	1-0601B-A-M0456-001-00D	Process Mechanical - Standard Details
WB-M0457	1-0601B-A-M0457-001-00D	Process Mechanical - Standard Details
WB-M0458	1-0601B-A-M0458-001-00D	Process Mechanical - Standard Details
WB-M0459	1-0601B-A-M0459-001-00D	Process Mechanical - Standard Details
WB-M0460	1-0601B-A-M0460-001-00D	Process Mechanical - Standard Details
WB-M0461	1-0601B-A-M0461-001-00D	Process Mechanical - Standard Details
WB-M0462	1-0601B-A-M0462-001-00D	Process Mechanical - Standard Details
WB-M0463	1-0601B-A-M0463-001-00D	Process Mechanical - Standard Details
WB-M0464	1-0601B-A-M0464-001-00D	Process Mechanical - Standard Details
WB-M0465	1-0601B-A-M0465-001-00D	Process Mechanical - Standard Details
WB-M0466	1-0601B-A-M0466-001-00D	Process Mechanical - Standard Details
WB-M9451	1-0601B-A-M9451-001-00D	Process Mechanical - Standard Details
WB-M9452	1-0601B-A-M9452-001-00D	Process Mechanical - Standard Details
WB-M9453	1-0601B-A-M9453-001-00D	Process Mechanical - Standard Details
WB-M9454	1-0601B-A-M9454-001-00D	Process Mechanical - Standard Details
WC-E0111	1-0601C-A-E0111-001-00D	Electrical - Chemical Area - First Floor Facility Plan
WC-E0112	1-0601C-A-E0112-001-00D	Electrical - Chemical Area - First Floor Process Plan
WC-E0113	1-0601C-A-E0113-001-00D	Electrical - Chemical Area - First Floor Power and Lighting Plan
WC-E0121	1-0601C-A-E0121-001-00D	Electrical - Chemical Area - Second Floor Facility Plan
WC-E0122	1-0601C-A-E0122-001-00D	Electrical - Chemical Area - Second Floor Process Plan
WC-E0123	1-0601C-A-E0123-001-00D	Electrical - Chemical Area - Second Floor Power and Lighting Plan
WC-E0131	1-0601C-A-E0131-001-00D	Electrical - Chemical Area - Third Floor Facility Plan
WC-E0133	1-0601C-A-E0133-001-00D	Electrical - Chemical Area - Third Floor Power and Lignting Plan
WC-E0145	1-0601C-A-E0145-001-00D	Electical - Chemical Area - Roof Facility Plan
WC-E0147	1-0601C-A-E0147-001-00D	Electical - Chemical Area - Roof Power and Lighting Plan
WC-E0201	1-0601C-A-E0201-001-00D	Electrical - Chemical Area - Stair Lighting
WC-H0111	1-0601C-A-H0111-001-00D	HVAC - Chemical Area - First Floor Plan
WC-H0112	1-0601C-A-H0112-001-00D	Plumbing - Chemical Area - First Floor Plan
WC-H0121	1-0601C-A-H0121-001-00D	HVAC - Chemical Area - Second Floor Plan
WC-H0122	1-0601C-A-H0122-001-00D	Plumbing - Chemical Area - Second Floor Plan
WC-H0131	1-0601C-A-H0131-001-00D	HVAC - Chemical Area - Third Floor Plan
WC-H0132	1-0601C-A-H0132-001-00D	Plumbing - Chemical Area - Third Floor Plan
WC-H0142	1-0601C-A-H0142-001-00D	Plumbing - Chemical Area - Roof Plan
WC-H9112	1-0601C-A-H9112-001-00D	Plumbing - Pipe Embeds - Chemical Area First Floor Plan
WC-H9122	1-0601C-A-H9122-001-00D	Plumbing - Pipe Embeds - Chemical Area Second Floor Plan
WC-H9132	1-0601C-A-H9132-001-00D	Plumbing - Pipe Embeds - Chemical Area Third Floor Plan
WC-M0111	1-0601C-A-M0111-001-00D	Process Mechanical - Chemical Area - First Floor Layout
WC-M0121	1-0601C-A-M0121-001-00D	Process Mechanical - Chemical Area - Second Floor Layout
WC-M0201	1-0601C-A-M0201-001-00D	Process Mechanical - Chemical Area - Section
WC-M0202	1-0601C-A-M0202-001-00D	Process Mechanical - Chemical Area - Section
WC-M0203	1-0601C-A-M0203-001-00D	Process Mechanical - Chemical Area - Section
WC-M0204	1-0601C-A-M0204-001-00D	Process Mechanical - Chemical Area - Sections
WC-M0205	1-0601C-A-M0205-001-00D	Process Mechanical - Chemical Area - Section
WC-M0206	1-0601C-A-M0206-001-00D	Process Mechanical - Chemical Area - Section
WC-M0207	1-0601C-A-M0207-001-00D	Process Mechanical - Chemical Area - Sections
WC-M0208	1-0601C-A-M0208-001-00D	Process Mechanical - Chemical Area - Sections
WC-M0209	1-0601C-A-M0209-001-00D	Process Mechanical - Backwash Pump Gallery - Sodium Hypochlorite Piping - Sections
WC-M0401	1-0601C-A-M0401-001-00D	Process Mechanical - Chemical Area - Plan Detail
WC-M0402	1-0601C-A-M0402-001-00D	Process Mechanical - Chemical Area - Plan Detail

Consultant Drawing No.	City Drawing No.	Drawing Title
WC-M0403	1-0601C-A-M0403-001-00D	Process Mechanical - Sodium Bisulphite and Peroxide - Storage and Feed Rooms - Plan Details
WC-M0404	1-0601C-A-M0404-001-00D	Process Mechanical - Access Corridor No.3 - Plan Detail
WC-M0406	1-0601C-A-M0406-001-00D	Process Mechanical - Filter and Mixing Chamber Area - Plan Detail
WC-M0451	1-0601C-A-M0451-001-00D	Process Mechanical - Chemical Area - Details
WC-M0452	1-0601C-A-M0452-001-00D	Process Mechanical - Chemical Area - Details
WC-M0453	1-0601C-A-M0453-001-00D	Process Mechanical - Chemical Area - Details
WC-M0454	1-0601C-A-M0454-001-00D	Process Mechanical - Chemical Area - Details
WC-M0455	1-0601C-A-M0455-001-00D	Process Mechanical - Chemical Area - Details
WC-M0456	1-0601C-A-M0456-001-00D	Process Mechanical - Chemical Area - Details
WC-M9111	1-0601C-A-M9111-001-00D	Process Mechanical - Pipe Embeds - Chemical Area Plan
WC-M9201	1-0601C-A-M9201-001-00D	Process Mechanical - Pipe Embeds - Chemical Area Sections
WC-M9401	1-0601C-A-M9401-001-00D	Process Mechanical - Pipe Embeds - Polymer Area First Floor Plan Detail
WC-M9402	1-0601C-A-M9402-001-00D	Process Mechanical - Pipe Embeds - Polymer Area Second Floor Plan Detail
WC-M9403	1-0601C-A-M9403-001-01D	Process Mechanical - Pipe Embeds - SBS and Peroxide Area Plan Details
WC-P0001	1-0601C-G-P0001-001-00D	Process - Hydrogen Peroxide Storage - Process & Instrumentation Diagram
WC-P0002	1-0601C-G-P0002-001-00D	Process - Hydrogen Peroxide and Chemical Feed Systems - Process & Instrumentation Diagram
WC-P0003	1-0601C-G-P0003-001-00D	Process - Sodium Bisulphite Offloading and Storage - Process & Instrumentation Diagram
WC-P0004	1-0601C-G-P0004-001-00D	Process - Sodium Bisulphite Chemical Feed Systems - Process & Instrumentation Diagram
WC-P0005	1-0601C-G-P0005-001-00D	Process - Dry Polymer Bulk Bag Unloading and Conveyance - Process & Instrumentation Diagram
WC-P0006	1-0601C-G-P0006-001-00D	Process - Polymer Preparation Systems DAF/Filter - Process & Instrumentation Diagram
WC-P0007	1-0601C-G-P0007-001-00D	Process - Polymer Preparation Systems Residuals - Process & Instrumentation Diagram
WC-P0008	1-0601C-G-P0008-001-00D	Process - Polymer Feed Tanks DAF/Filters - Process & Instrumentation Diagram
WC-P0009	1-0601C-G-P0009-001-00D	Process - Polymer Feed Tanks Residuals - Process & Instrumentation Diagram
WC-P0014	1-0601C-G-P0014-001-00D	Process - Polymer Filter Feed Pumps - Process & Instrumentation Diagram
WC-P0015	1-0601C-G-P0015-001-00D	Process - Polymer Sludge Feed Pumps - Process & Instrumentation Diagram
WF-E0101	1-0601F-A-E0101-001-00D	Electrical - Filtration Area 1 - Lower Level Facility Plan
WF-E0102	1-0601F-A-E0102-001-00D	Electrical - Filtration Area 2 - Lower Level Facility Plan
WF-E0103	1-0601F-A-E0103-001-00D	Electrical - Filtration Area 1 - Lower Level Process Plan
WF-E0104	1-0601F-A-E0104-001-00D	Electrical - Filtration Area 2 - Lower Level Process Plan
WF-E0105	1-0601F-A-E0105-001-00D	Electrical - Filtration Area 1 - Lower Level Power and Lighting Plan
WF-E0106	1-0601F-A-E0106-001-00D	Electrical - Filtration Area 2 - Lower Level Power and Lighting Plan
WF-E0121	1-0601F-A-E0121-001-00D	Electrical - Filtration Area 1 - Second Floor Facility Plan
WF-E0122	1-0601F-A-E0122-001-00D	Electrical - Filtration Area 2 - Upper Channel Facility Plan
WF-E0123	1-0601F-A-E0123-001-00D	Electrical - Filtration Area 1 - Second Floor Process Plan
WF-E0125	1-0601F-A-E0125-001-00D	Electrical - Filtration Area 1 - Second Floor Power and Lighting Plan
WF-E0131	1-0601F-A-E0131-001-00D	Electrical - Filtration Area 1 - Third Floor Facility Plan
WF-E0132	1-0601F-A-E0132-001-00D	Electrical - Filtration Area 2 - Third Floor Facility Plan
WF-E0133	1-0601F-A-E0133-001-00D	Electrical - Filtration Area 1 - Third Floor Process Plan
WF-E0134	1-0601F-A-E0134-001-00D	Electrical - Filtration Area 2 - Third Floor Process Plan
WF-E0135	1-0601F-A-E0135-001-00D	Electrical - Filtration Area 1 - Third Floor Power and Lighting Plan
WF-E0136	1-0601F-A-E0136-001-00D	Electrical - Filtration Area 2 - Third Floor Power and Lighting Plan
WF-E0201	1-0601F-A-E0201-001-00D	Electrical - Filtration Area - Stair Lighting
WF-H0104	1-0601F-A-H0104-001-00D	Plumbing - Filtration Area 1 - Lower Level Plan
WF-H0105	1-0601F-A-H0105-001-00D	Plumbing - Filtration Area 2 - Lower Level Plan
WF-H0106	1-0601F-A-H0106-001-00D	Plumbing - Backwash Area - Lower Level Plan
WF-H0111	1-0601F-A-H0111-001-00D	HVAC - Filtration Area 1 - First Floor Plan
WF-H0112	1-0601F-A-H0112-001-00D	HVAC - Filtration Area 2 - First Floor Plan

Consultant Drawing No.	City Drawing No.	Drawing Title
WF-H0113	1-0601F-A-H0113-001-00D	Plumbing - Filtration Area 1 - First Floor Plan
WF-H0114	1-0601F-A-H0114-001-00D	Plumbing - Filtration Area 2 - First Floor Plan
WF-H0121	1-0601F-A-H0121-001-00D	HVAC - Filtration Area 1 - Second Floor Plan
WF-H0131	1-0601F-A-H0131-001-00D	HVAC - Filtration Area 1 - Third Floor Plan
WF-H0132	1-0601F-A-H0132-001-00D	HVAC - Filtration Area 2 - Third Floor Plan
WF-H0133	1-0601F-A-H0133-001-00D	Plumbing - Filtration Area 1 - Partial Second Floor and Third Floor Plan
WF-H0134	1-0601F-A-H0134-001-00D	Plumbing - Filtration Area 2 - Third Floor Plan
WF-H0143	1-0601F-A-H0143-001-00D	Plumbing - Filtration Area 1 - Roof Plan
WF-H0144	1-0601F-A-H0144-001-00D	Plumbing - Filtration Area 2 - Roof Plan
WF-H9104	1-0601F-A-H9104-001-01D	Plumbing - Pipe Embeds - Filtration Area 1 Lower Level Plan
WF-H9105	1-0601F-A-H9105-001-00D	Plumbing - Pipe Embeds - Filtration Area 2 Lower Level Plan
WF-H9106	1-0601F-A-H9106-001-00D	Plumbing - Pipe Embeds - Backwash Pump Room Lower Level Plan
WF-H9133	1-0601F-A-H9133-001-00D	Plumbing - Pipe Embeds - Filtration Area 1 Third Floor Plan
WF-H9134	1-0601F-A-H9134-001-00D	Plumbing - Pipe Embeds - Filtration Area 2 Third Floor Plan
WF-M0101	1-0601F-A-M0101-001-00D	Process Mechanical - Filtration Pipe Gallery Area 1 - Lower Plan
WF-M0102	1-0601F-A-M0102-001-00D	Process Mechanical - Filtration Pipe Gallery Area 2 - Lower Plan
WF-M0103	1-0601F-A-M0103-001-00D	Process Mechanical - Filtration Backwash Pump Gallery Area 3 - Lower Plan
WF-M0111	1-0601F-A-M0111-001-00D	Process Mechanical - Filtration Pipe Gallery Area 1 - Upper Plan
WF-M0112	1-0601F-A-M0112-001-00D	Process Mechanical - Filtration Pipe Gallery Area 2 - Upper Plan
WF-M0121	1-0601F-A-M0121-001-00D	Process Mechanical - Filtration Area 1 - Upper Channel Plan
WF-M0122	1-0601F-A-M0122-001-00D	Process Mechanical - Filtration Area 2 - Upper Channel Plan
WF-M0131	1-0601F-A-M0131-001-00D	Process Mechanical - Filtration Area 1 - Third Floor Plan
WF-M0132	1-0601F-A-M0132-001-00D	Process Mechanical - Filtration Area 2 - Third Floor Plan
WF-M0201	1-0601F-A-M0201-001-00D	Process Mechanical - Filtration Area - Section
WF-M0202	1-0601F-A-M0202-001-00D	Process Mechanical - Filtration Area - Section
WF-M0203	1-0601F-A-M0203-001-00D	Process Mechanical - Filtration Area - Section
WF-M0204	1-0601F-A-M0204-001-00D	Process Mechanical - Filtration Area - Section
WF-M0205	1-0601F-A-M0205-001-00D	Process Mechanical - Filtration Area - Section
WF-M0206	1-0601F-A-M0206-001-00D	Process Mechanical - Filtration Area - Section
WF-M0207	1-0601F-A-M0207-001-00D	Process Mechanical - Filtration Area - Section
WF-M0208	1-0601F-A-M0208-001-00D	Process Mechanical - Filtration Area - Section
WF-M0209	1-0601F-A-M0209-001-00D	Process Mechanical - Filtration Area - Section
WF-M0210	1-0601F-A-M0210-001-00D	Process Mechanical - Filtration Area - Section
WF-M0401	1-0601F-A-M0401-001-00D	Process Mechanical - Filtration Pipe Gallery Area - Plan Detail
WF-M0402	1-0601F-A-M0402-001-00D	Process Mechanical - Filtration Pipe Gallery Area - Plan Detail
WF-M0403	1-0601F-A-M0403-001-00D	Process Mechanical - Filtration Pipe Gallery Area - Plan Detail
WF-M0404	1-0601F-A-M0404-001-00D	Process Mechanical - Filtration Pipe Gallery Area - Plan Detail
WF-M0405	1-0601F-A-M0405-001-00D	Process Mechanical - Filtration Backwash Pump Gallery Area - Plan Detail
WF-M0406	1-0601F-A-M0406-001-00D	Process Mechanical - Filtration Blower Room Area - Plan Detail
WF-M0407	1-0601F-A-M0407-001-00D	Process Mechanical - Filtration Backwash Pump Gallery Area - Section Details
WF-M0451	1-0601F-A-M0451-001-00D	Process Mechanical - Filtration Area - Standard Details
WF-M0452	1-0601F-A-M0452-001-00D	Process Mechanical - Filtration Area - Standard Details
WF-M9101	1-0601F-A-M9101-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 1 Lower Plan
WF-M9102	1-0601F-A-M9102-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 2 Lower Plan
WF-M9103	1-0601F-A-M9103-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 3 Lower Plan
WF-M9111	1-0601F-A-M9111-001-00D	Process Mechanical - Pipe Embeds - Filtration Pipe Gallery Area 1
WF-M9112	1-0601F-A-M9112-001-00D	Process Mechanical - Pipe Embeds - Filtration Pipe Gallery Area 2
WF-M9121	1-0601F-A-M9121-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 1 Upper Channel Level Plan
WF-M9122	1-0601F-A-M9122-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 2 Upper Channel Level Plan
WF-M9131	1-0601F-A-M9131-001-00D	Process Mechanical - Pipe Embeds - Filtration Area 1 Third Floor Plan
WF-M9132	1-0601F-A-M9132-001-01D	Process Mechanical - Pipe Embeds - Filtration Area 2 Third Floor Plan

Consultant Drawing No.	City Drawing No.	Drawing Title
WF-M9201	1-0601F-A-M9201-001-01D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-M9205	1-0601F-A-M9205-001-01D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-M9206	1-0601F-A-M9206-001-01D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-M9207	1-0601F-A-M9207-001-00D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-M9208	1-0601F-A-M9208-001-01D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-M9209	1-0601F-A-M9209-001-01D	Process Mechanical - Pipe Embeds - Filtration Area Section
WF-P0001	1-0601F-G-P0001-001-00D	Process - Filter No.1 - Process and Instrumentation Diagram
WF-P0002	1-0601F-G-P0002-001-00D	Process - Filter No.2 - Process and Instrumentation Diagram
WF-P0003	1-0601F-G-P0003-001-00D	Process - Filter No.3 - Process and Instrumentation Diagram
WF-P0004	1-0601F-G-P0004-001-00D	Process - Filter No.4 - Process and Instrumentation Diagram
WF-P0005	1-0601F-G-P0005-001-00D	Process - Filter No.5 - Process and Instrumentation Diagram
WF-P0006	1-0601F-G-P0006-001-00D	Process - Filter No.6 - Process and Instrumentation Diagram
WF-P0007	1-0601F-G-P0007-001-00D	Process - Filter No.7 - Process and Instrumentation Diagram
WF-P0008	1-0601F-G-P0008-001-00D	Process - Filter No.8 - Process and Instrumentation Diagram
WF-P0009	1-0601F-G-P0009-001-00D	Process - Backwash Supply Pumps - Process and Instrumentation Diagram
WF-P0010	1-0601F-G-P0010-001-00D	Process - Air Scour Supply Blowers - Process and Instrumentation Diagram
WF-P0011	1-0601F-G-P0011-001-00D	Process - Filtration - Process and Instrumentation Diagram
WF-P0012	1-0601F-G-P0012-001-00D	Process - Backwash Area Process Sump Pumps - Process and Instrumentation Diagram
WF-P0013	1-0601F-G-P0013-001-00D	Process - Backwash Supply Pumps - Process and Instrumentation Diagram
WF-P0014	1-0601F-G-P0014-001-00D	Process - Filtration - Process and Instrumentation Diagram
WH-A0101	1-0601H-C-A0101-001-00D	Automation / I & C - Plant Communication Network - Fibre Optic Cable Routing Diagram
WH-A0102	1-0601H-E-A0102-001-00D	Automation / I & C - Plant Communication Network - Block Diagram
WH-A0103	1-0601H-E-A0103-001-00D	Automation / I & C - Plant Communication Network - Block Diagram
WH-A0104	1-0601H-E-A0104-001-00D	Automation / I & C - Plant Communication Network - Block Diagram
WH-A0105	1-0601H-E-A0105-001-00D	Automation / I & C - Plant Communication Network - Block Diagram
WH-A0501	1-0601H-J-A0501-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0502	1-0601H-J-A0502-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0503	1-0601H-J-A0503-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0504	1-0601H-J-A0504-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0505	1-0601H-J-A0505-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0506	1-0601H-J-A0506-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0507	1-0601H-J-A0507-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0508	1-0601H-J-A0508-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0509	1-0601H-J-A0509-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0510	1-0601H-J-A0510-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0511	1-0601H-J-A0511-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0512	1-0601H-J-A0512-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0513	1-0601H-J-A0513-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0514	1-0601H-J-A0514-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0515	1-0601H-J-A0515-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0516	1-0601H-J-A0516-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0517	1-0601H-J-A0517-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0518	1-0601H-J-A0518-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0519	1-0601H-J-A0519-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0520	1-0601H-J-A0520-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0521	1-0601H-J-A0521-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0522	1-0601H-J-A0522-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0523	1-0601H-J-A0523-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0524	1-0601H-J-A0524-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0525	1-0601H-J-A0525-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0526	1-0601H-J-A0526-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams

Consultant Drawing No.	City Drawing No.	Drawing Title
WH-A0527	1-0601H-J-A0527-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0528	1-0601H-J-A0528-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0529	1-0601H-J-A0529-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0530	1-0601H-J-A0530-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0531	1-0601H-J-A0531-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0532	1-0601H-J-A0532-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0533	1-0601H-J-A0533-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0534	1-0601H-J-A0534-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0535	1-0601H-J-A0535-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0536	1-0601H-J-A0536-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0537	1-0601H-J-A0537-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0538	1-0601H-J-A0538-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0539	1-0601H-J-A0539-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0540	1-0601H-J-A0540-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0541	1-0601H-J-A0541-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0542	1-0601H-J-A0542-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0543	1-0601H-J-A0543-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0544	1-0601H-J-A0544-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0545	1-0601H-J-A0545-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0546	1-0601H-J-A0546-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0547	1-0601H-J-A0547-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0548	1-0601H-J-A0548-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0549	1-0601H-J-A0549-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0550	1-0601H-J-A0550-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0551	1-0601H-J-A0551-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0552	1-0601H-J-A0552-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0553	1-0601H-J-A0553-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0554	1-0601H-J-A0554-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0555	1-0601H-J-A0555-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0556	1-0601H-J-A0556-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0557	1-0601H-J-A0557-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0558	1-0601H-J-A0558-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0559	1-0601H-J-A0559-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0560	1-0601H-J-A0560-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0561	1-0601H-J-A0561-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0562	1-0601H-J-A0562-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0563	1-0601H-J-A0563-001-00B	Automation / I and C - Plant Communication Cable - Termination Diagrams
WH-A0601	1-0601H-K-A0601-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0602	1-0601H-K-A0602-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0603	1-0601H-K-A0603-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0604	1-0601H-K-A0604-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0605	1-0601H-K-A0605-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0606	1-0601H-K-A0606-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0607	1-0601H-K-A0607-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0608	1-0601H-K-A0608-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-A0609	1-0601H-K-A0609-001-00B	Automation / I and C - Plant Communication Cables - Cable List
WH-P0001	1-0601H-G-P0001-001-00D	Process - Sanitary Sump - Fire Pump Room - Process and Instrumentation Diagram
WH-P0002	1-0601H-G-P0002-001-00D	Process - Sanitary Sump - Backwash Pump Gallery - Process and Instrumentation Diagram
WH-P0003	1-0601H-G-P0003-001-00D	Process - Sanitary Sump - Elevator Pit - Process and Instrumentation Diagram
WH-P0004	1-0601H-G-P0004-001-00D	Process - Sanitary Sump - Administration Area - Process and Instrumentation Diagram
WH-P0005	1-0601H-G-P0005-001-00D	Process - Potable Water - Process & Instrumentation Diagram

Consultant Drawing No.	City Drawing No.	Drawing Title
WH-P0006	1-0601H-G-P0006-001-00D	Process - Fire Pumps - Process and Instrumentation Diagram
WH-P0007	1-0601H-G-P0007-001-00D	Process - Process Sump - Fire Pump Room - Process and Instrumentation Diagram
WH-P0008	1-0601H-G-P0008-001-00D	Process - Compressed Air System - Process and Instrumentation Diagram
WI-E0101	1-0601I-A-E0101-001-00D	Electrical - Raw Water Pump Station Area - Lower Level Facility Plan
WI-E0102	1-0601I-A-E0102-001-00D	Electrical - Raw Water Pump Station Area - Lower Level Process Plan
WI-E0103	1-0601I-A-E0103-001-00D	Electrical - Raw Water Pump Station Area - Lower Level Power and Lighting Plan
WI-E0111	1-0601I-A-E0111-001-00D	Electrical - Raw Water Pump Station Area - First Floor Facility Plan
WI-E0112	1-0601I-A-E0112-001-00D	Electrical - Raw Water Pump Station Area - First Floor Process Plan
WI-E0113	1-0601I-A-E0113-001-00D	Electrical - Raw Water Pump Station Area - First Floor Power and Lighting Plan
WI-E0131	1-0601I-A-E0131-001-00D	Electrical - Raw Water Pump Station Area - Third Floor Facility Plan
WI-E0132	1-0601I-A-E0132-001-00D	Electrical - Raw Water Pump Station Area - Third Floor Process Plan
WI-E0133	1-0601I-A-E0133-001-00D	Electrical - Raw Water Pump Station Area - Third Floor Power and Lighting Plan
WI-E0201	1-0601I-A-E0201-001-00D	Electrical - Raw Water Pump Station Area - Stair Lighting
WI-H0111	1-0601I-A-H0111-001-00D	HVAC - Raw Water Pump Station Area - First Floor Plan
WI-H0122	1-0601I-A-H0122-001-00D	Plumbing - Raw Water Pump Station Area - Lower Level and Third Floor Plan
WI-H0131	1-0601I-A-H0131-001-00D	HVAC - Raw Water Pump Station Area - Third Floor Plan
WI-H0142	1-0601I-A-H0142-001-00D	Plumbing - Raw Water Pump Station - Roof Plan
WI-M0101	1-0601I-A-M0101-001-00D	Process Mechanical - Raw Water Pump Station Area - Lower Level Plan
WI-M0131	1-0601I-A-M0131-001-00D	Process Mechanical - Raw Water Pump Station Area - Third Floor Plan
WI-M0201	1-0601I-A-M0201-001-00D	Process Mechanical - Raw Water Pump Station Area - Section
WI-M0202	1-0601I-A-M0202-001-00D	Process Mechanical - Raw Water Pump Station Area - Section
WI-M0203	1-0601I-A-M0203-001-00D	Process Mechanical - Raw Water Pump Station Area - Section
WI-P0001	1-0601I-G-P0001-001-00D	Process - Raw Water Pump Station Area - Process and Instrumentation Diagram
WI-P0002	1-0601I-G-P0002-001-00D	Process - Raw Water Pump Station Area - Process and Instrumentation Diagram
WI-P0003	1-0601I-G-P0003-001-00D	Process - Raw Water Pump Station Area - Process and Instrumentation Diagram
WI-P0004	1-0601I-G-P0004-001-00D	Process - Raw Water Pump Station Area - Process and Instrumentation Diagram
WM-E0010	1-0601M-D-E0010-001-00D	Electrical - Symbols - Legend
WM-E0011	1-0601M-D-E0011-001-00D	Electrical - Symbols - Legend
WM-E0111	1-0601M-A-E0111-001-00D	Electrical - Electrical Room Area - First Floor Facility Plan
WM-E0112	1-0601M-A-E0112-001-00D	Electrical - Electrical Room Area - First Floor Process Plan
WM-E0113	1-0601M-A-E0113-001-00D	Electrical - Electrical Room Area - First Floor Power and Lighting Plan
WM-E0131	1-0601M-A-E0131-001-00D	Electrical - Electrical Room Layout - Third Floor Facility Plan
WM-E0133	1-0601M-A-E0133-001-00D	Electrical - Electrical Room Layout - Third Floor Power and Lighting Plan
WM-G0001	1-0601M-G-G0001-001-00D	General - Main Process - Hydraulic Profile
WM-G0002	1-0601M-D-G0002-001-00D	General - Residuals Handling - Hydraulic Profile
WM-G0003	1-0601M-G-G0003-001-00D	General - Process Flow Diagram
WM-H0001	1-0601M-D-H0001-001-00D	Mechanical - Legend and Symbols
WM-H0112	1-0601M-A-H0112-001-00D	Plumbing - Fire Pump and Electrical Room - First Floor and Third Floor Plans
WM-H0113	1-0601M-A-H0113-001-00D	Fire Protection - Fire Pump Room - Lower Level and First Floor Plans
WM-H0142	1-0601M-A-H0142-001-00D	Plumbing - Fire Pump and Electrical Room - Roof Plan
WM-H0261	1-0601M-A-H0261-001-00D	Fire Protection - Fire Pump Room - Sections
WM-H0262	1-0601M-A-H0262-001-00D	Fire Protection - Fire Pump Room - Sections
WM-H9112	1-0601M-A-H9112-001-00D	Plumbing - Pipe Embeds - Fire Pump and Electrical Room First Floor Plan
WM-P0001	1-0601M-D-P0001-001-00D	Construction Standards - Process and Instrumentation - Identification
WM-P0002	1-0601M-D-P0002-001-00D	Construction Standards - Process and Instrumentation - Symbols
WO-E0131	1-0601O-A-E0131-001-00D	Electrical - Ozonation Area - Third Floor Facility Plan
WO-E0132	1-0601O-A-E0132-001-00D	Electrical - Ozonation Area - Third Floor Process Plan
WO-E0133	1-0601O-A-E0133-001-00D	Electrical - Ozonation Area - Third Floor Power and Lighting Plan
WO-E0145	1-0601O-A-E0145-001-00D	Electrical - Ozonation Area - Roof Facility Plan
WO-H0111	1-0601O-A-H0111-001-00D	HVAC - Ozonation Area - First Floor Plan
WO-H0112	1-0601O-A-H0112-001-00D	Plumbing - Ozonation Area - First Floor Plan

Consultant Drawing No.	City Drawing No.	Drawing Title
WO-H0131	1-0601O-A-H0131-001-00D	HVAC - Ozonation Area - Third Floor Plan
WO-H0132	1-0601O-A-H0132-001-00D	Plumbing - Ozonation Area - Third Floor Plan
WO-H0142	1-0601O-A-H0142-001-00D	Plumbing - Ozonation Area - Roof Plan
WO-H9112	1-0601O-A-H9112-001-00D	Plumbing - Pipe Embeds - Ozonation Area First Floor Plan
WO-H9132	1-0601O-A-H9132-001-00D	Plumbing - Pipe Embeds - Ozonation Area Third Floor Plan
WO-M0121	1-0601O-A-M0121-001-00D	Process Mechanical - Ozonation Area - Contactors
WO-M0131	1-0601O-A-M0131-001-00D	Process Mechanical - Ozonation Area - Third Floor Plan
WO-M0201	1-0601O-A-M0201-001-00D	Process Mechanical - Ozonation Area - Sections
WO-M0202	1-0601O-A-M0202-001-00D	Process Mechanical - Ozonation Area - Section
WO-M0203	1-0601O-A-M0203-001-00D	Process Mechanical - Ozonation Area - Section
WO-M0204	1-0601O-A-M0204-001-00D	Process Mechanical - Ozonation Area - Section
WO-M0205	1-0601O-A-M0205-001-00D	Process Mechanical - Ozonation Area - Section
WO-M0206	1-0601O-A-M0206-001-00D	Process Mechanical - Ozonation Area - Section
WO-M0401	1-0601O-A-M0401-001-00D	Process Mechanical - Ozonation Area - Plan Detail
WO-M0402	1-0601O-A-M0402-001-00D	Process Mechanical - Ozonation Area - Plan Detail
WO-M0403	1-0601O-A-M0403-001-00D	Process Mechanical - Ozonation Area - Section Details
WO-M9121	1-0601O-A-M9121-001-01D	Process Mechanical - Pipe Embeds - Ozone Contactors Upper Plan
WO-M9131	1-0601O-A-M9131-001-00D	Process Mechanical - Pipe Embeds - Ozone Generation Room Third Floor Plan
WO-M9201	1-0601O-A-M9201-001-01D	Process Mechanical - Pipe Embeds - Section
WO-M9202	1-0601O-A-M9202-001-00D	Process Mechanical - Pipe Embeds - Section Details
WO-M9203	1-0601O-A-M9203-001-00D	Process Mechanical - Pipe Embeds - Section Details
WO-P0001	1-0601O-G-P0001-001-00D	Ozonation Area - Liquid Oxygen Storage System No.1 - Process and Instrumentation Diagram
WO-P0002	1-0601O-G-P0002-001-00D	Ozonation Area - Liquid Oxygen Storage System No.2 - Process and Instrumentation Diagram
WO-P0003	1-0601O-G-P0003-001-00D	Ozonation Area - GOX Preparation System - Process and Instrumentation Diagram
WO-P0004	1-0601O-G-P0004-001-00D	Ozonation Area - Nitrogen Boost Unit - Process and Instrumentation Diagram
WO-P0005	1-0601O-G-P0005-001-00D	Ozonation Area - Ozone Generator No. 1 - Process and Instrumentation Diagram
WO-P0006	1-0601O-G-P0006-001-00D	Ozonation Area - Ozone Generator No. 2 - Process and Instrumentation Diagram
WO-P0007	1-0601O-G-P0007-001-00D	Ozonation Area - Ozone Generator No. 3 - Process and Instrumentation Diagram
WO-P0008	1-0601O-G-P0008-001-00D	Ozonation Area - Ozone Flow Control No.1 - Process and Instrumentation Diagram
WO-P0009	1-0601O-G-P0009-001-00D	Ozonation Area - Ozone Flow Control No.2 - Process and Instrumentation Diagram
WO-P0010	1-0601O-G-P0010-001-00D	Ozonation Area - Ozone Contactor No 1 - Process and Instrumentation Diagram
WO-P0011	1-0601O-G-P0011-001-00D	Ozonation Area - Ozone Contactor No 2 - Process and Instrumentation Diagram
WO-P0012	1-0601O-G-P0012-001-00D	Ozonation Area - Ozone Destruct Unit No. 1 - Process and Instrumentation Diagram
WO-P0013	1-0601O-G-P0013-001-00D	Ozonation Area - Ozone Destruct Unit No. 2 - Process and Instrumentation Diagram
WO-P0014	1-0601O-G-P0014-001-00D	Ozonation Area - Ozone Destruct Unit No. 3 - Process and Instrumentation Diagram
WO-P0015	1-0601O-G-P0015-001-00D	Ozonation Area - Open Loop Cooling Water Supply - Process and Instrumentation Diagram
WO-P0016	1-0601O-G-P0016-001-00D	Ozonation Area - Cooling Water Skid No.1 - Process and Instrumentation Diagram
WO-P0017	1-0601O-G-P0017-001-00D	Ozonation Area - Cooling Water Skid No.2 - Process and Instrumentation Diagram
WO-P0018	1-0601O-G-P0018-001-00D	Ozonation Area - Cooling Water Skid No.3 - Process and Instrumentation Diagram
WO-P0019	1-0601O-G-P0019-001-00D	Ozonation Area - Power Supply Unit No.1 - Process and Instrumentation Diagram
WO-P0020	1-0601O-G-P0020-001-00D	Ozonation Area - Power Supply Unit No.2 - Process and Instrumentation Diagram
WO-P0021	1-0601O-G-P0021-001-00D	Ozonation Area - Power Supply Unit No.3 - Process and Instrumentation Diagram
WO-P0022	1-0601O-G-P0022-001-00D	Ozonation Area - Dissolved Ozone Sampling System No.1 - Process and Instrumentation Diagram
WO-P0023	1-0601O-G-P0023-001-00D	Ozonation Area - Dissolved Ozone Sampling System No.2 - Process and Instrumentation Diagram
WP-E0111	1-0601P-A-E0111-001-00D	Electrical - Floc/DAF Area 1 - First Floor Facility Plan
WP-E0112	1-0601P-A-E0112-001-00D	Electrical - Floc/DAF Area 2 - First Floor Facility Plan
WP-E0113	1-0601P-A-E0113-001-00D	Electrical - Floc/DAF Area 1 - First Floor Process Plan
WP-E0114	1-0601P-A-E0114-001-00D	Electrical - Floc/DAF Area 2 - First Floor Process Plan

Consultant Drawing No.	City Drawing No.	Drawing Title
WP-E0115	1-0601P-A-E0115-001-00D	Electrical - Floc/DAF Area 1 - First Floor Power and Lighting Plan
WP-E0116	1-0601P-A-E0116-001-00D	Electrical - Floc/DAF Area 2 - First Floor Power and Lighting Plan
WP-E0131	1-0601P-A-E0131-001-00D	Electrical - Floc/DAF Area 1 - Third Floor Facility Plan
WP-E0132	1-0601P-A-E0132-001-00D	Electrical - Floc/DAF Area 2 - Third Floor Facility Plan
WP-E0133	1-0601P-A-E0133-001-00D	Electrical - Floc/DAF Area 1 - Third Floor Process Plan
WP-E0134	1-0601P-A-E0134-001-00D	Electrical - Floc/DAF Area 2 - Third Floor Process Plan
WP-E0135	1-0601P-A-E0135-001-00D	Electrical - Floc/DAF Area 1 - Third Floor Power and Lighting Plan
WP-E0136	1-0601P-A-E0136-001-00D	Electrical - Floc/DAF Area 2 - Third Floor Power and Lighting Plan
WP-H0111	1-0601P-A-H0111-001-00D	HVAC - Floc/DAF Area 1 - First Floor Plan
WP-H0112	1-0601P-A-H0112-001-00D	HVAC - Floc/DAF Area 2 - First Floor Plan
WP-H0113	1-0601P-A-H0113-001-00D	Plumbing - Floc/DAF Area 1 - First Floor Plan
WP-H0114	1-0601P-A-H0114-001-00D	Plumbing - Floc/DAF Area 2 - First Floor Plan
WP-H0121	1-0601P-A-H0121-001-00D	HVAC - Floc/DAF Area 1 - Second Floor Plan
WP-H0122	1-0601P-A-H0122-001-00D	HVAC - Floc/DAF Area 2 - Second Floor Plan
WP-H0131	1-0601P-A-H0131-001-00D	HVAC - Floc/DAF Area 1 - Third Floor Plan
WP-H0132	1-0601P-A-H0132-001-00D	HVAC - Floc/DAF Area 2 - Third Floor Plan
WP-H0133	1-0601P-A-H0133-001-00D	Plumbing - Floc/DAF Area 1 - Third Floor Plan
WP-H0134	1-0601P-A-H0134-001-00D	Plumbing - Floc/DAF Area 2 - Third Floor Plan
WP-H0143	1-0601P-A-H0143-001-00D	Plumbing - Floc/DAF Area 1 - Roof Plan
WP-H0144	1-0601P-A-H0144-001-00D	Plumbing - Floc/DAF Area 2 - Roof Plan
WP-H9113	1-0601A-A-H9113-001-00D	Plumbing - Pipe Embeds - Floc / DAF Area 1 First Floor Plan
WP-H9114	1-0601P-A-H9114-001-00D	Plumbing - Pipe Embeds - Floc / DAF Area 2 First Floor Plan
WP-H9133	1-0601P-A-H9133-001-00D	Plumbing - Pipe Embeds - Floc / DAF Area 1 Third Floor Plan
WP-H9134	1-0601P-A-H9134-001-00D	Plumbing - Pipe Embeds - Floc / DAF Area 2 Third Floor Plan
WP-M0110	1-0601P-A-M0110-001-00D	Process Mechanical - First Floor Plan - DAF Influent Gallery
WP-M0111	1-0601P-A-M0111-001-00D	Process Mechanical - First Floor Plan – DAF Influent Gallery
WP-M0115	1-0601P-A-M0115-001-00D	Process Mechanical - Lower Level Plan
WP-M0120	1-0601P-A-M0120-001-00D	Process Mechanical - Second Floor Plan
WP-M0130	1-0601P-A-M0130-001-00D	Process Mechanical - Third Floor Plan
WP-M0131	1-0601P-A-M0131-001-00D	Process Mechanical - Third Floor Plan - DAF Tanks 1 & 2 - Typ. DAF Tank Layout
WP-M0132	1-0601P-A-M0132-001-00D	Process Mechanical - Third Floor Plan - Flocculator Mixer Typical Layout
WP-M0201	1-0601P-A-M0201-001-00D	Process Mechanical - Sections A & B - DAF Influent Gallery
WP-M0202	1-0601P-A-M0202-001-00D	Process Mechanical - Sections C & D
WP-M0203	1-0601P-A-M0203-001-00D	Process Mechanical - Section E
WP-M0204	1-0601P-A-M0204-001-00D	Process Mechanical - Sections F,J & Q
WP-M0205	1-0601P-A-M0205-001-00D	Process Mechanical - Sections G & L
WP-M0206	1-0601P-A-M0206-001-00D	Process Mechanical - Sections M & N
WP-M0207	1-0601P-A-M0207-001-00D	Process Mechanical - Sections H & K
WP-M0208	1-0601P-A-M0208-001-00D	Process Mechanical - Sections A & B - Flash Pumps
WP-M0209	1-0601P-A-M0209-001-00D	Process Mechanical - Recycle and Float Pumps West End
WP-M0210	1-0601P-A-M0210-001-00D	Process Mechanical - Float and Recycle Pumps
WP-M0211	1-0601P-A-M0211-001-00D	Process Mechanical - Cooling Water Return Lines From Ozone Generators - Plan, Sections and Detail
WP-M0212	1-0601P-A-M0212-001-00D	Process Mechanical - Section D - DAF Tanks 1 & 2
WP-M0213	1-0601P-A-M0213-001-00D	Process Mechanical - Section E - DAF Tanks 1 & 2
WP-M0214	1-0601P-A-M0214-001-00D	Process Mechanical - DAF Influent Gallery - Plans and Sections
WP-M0451	1-0601P-A-M0451-001-00D	Process Mechanical - Standard Details
WP-M0452	1-0601P-A-M0452-001-00D	Process Mechanical - Standard Details
WP-M9101	1-0601P-A-M9101-001-00D	Pipe Embeds - Plan @ Elevation 244.400 and Sections - Flocculation and DAF Tanks
WP-M9102	1-0601P-A-M9102-001-00D	Pipe Embeds - First Floor Plan and Sections - Float Collection Sumps
WP-M9103	1-0601P-A-M9103-001-00D	Pipe Embeds - Third Floor Plan and Sections - Clarified Raw Water

Consultant Drawing No.	City Drawing No.	Drawing Title
WP-M9104	1-0601P-A-M9104-001-00D	Pipe Embeds - Second Floor Plan - Mud Valve Drain Lines
WP-M9105	1-0601P-A-M9105-001-01D	Pipe Embeds - Third Floor Plan and Sections - Ozone Cooling Water Return
WP-M9106	1-0601P-A-M9106-001-01D	Pipe Embeds - Plan and Sections - Supernatant and Sludge Lines
WP-M9107	1-0601P-A-M9107-001-00D	Pipe Embeds - First Floor Plan and Sections - Raw Water Sump Discharge Piping
WP-M9108	1-0601P-A-M9108-001-00D	Pipe Embeds - First Floor Plan and Sections - Ozone Contactor Drain
WP-P0001	1-0601P-G-P0001-001-00D	Process - Process and Instrumentation Diagram
WP-P0002	1-0601P-G-P0002-001-00D	Process - Process and Instrumentation Diagram
WP-P0003	1-0601P-G-P0003-001-00D	Process - Process and Instrumentation Diagram
WP-P0004	1-0601P-G-P0004-001-00D	Process - Flocculation /DAF Tank 1 - Process and Instrumentation Diagram
WP-P0005	1-0601P-G-P0005-001-00D	Process - Flocculation /DAF Tank 2 - Process and Instrumentation Diagram
WP-P0006	1-0601P-G-P0006-001-00D	Process - Flocculation /DAF Tank 3 - Process and Instrumentation Diagram
WP-P0007	1-0601P-G-P0007-001-00D	Process - Flocculation /DAF Tank 4 - Process and Instrumentation Diagram
WP-P0008	1-0601P-G-P0008-001-00D	Process - Flocculation /DAF Tank 5 - Process and Instrumentation Diagram
WP-P0009	1-0601P-G-P0009-001-00D	Process - Flocculation /DAF Tank 6 - Process and Instrumentation Diagram
WP-P0010	1-0601P-G-P0010-001-00D	Process - Flocculation /DAF Tank 7 - Process and Instrumentation Diagram
WP-P0011	1-0601P-G-P0011-001-00D	Process - Flocculation /DAF Tank 8 - Process and Instrumentation Diagram
WP-P0012	1-0601P-G-P0012-001-00D	Process - Recycle System 1 Of 2 - Process and Instrumentation Diagram
WP-P0013	1-0601P-G-P0013-001-00D	Process - Recycle System 2 Of 2 - Process and Instrumentation Diagram
WP-P0014	1-0601P-G-P0014-001-00D	Process - Recycle System 1 Of 2 - Process and Instrumentation Diagram
WP-P0015	1-0601P-G-P0015-001-00D	Process - Recycle System 2 Of 2 - Process and Instrumentation Diagram
WP-P0016	1-0601P-G-P0016-001-00D	Process - DAF Compressors - Process and Instrumentation Diagram
WP-P0017	1-0601P-G-P0017-001-00D	Process - DAF Effluent Channel - Process and Instrumentation Diagram
WP-P0018	1-0601P-G-P0018-001-00D	Process - DAF Float Sumps - Sheet 1 Of 2 - Process and Instrumentation Diagram
WP-P0019	1-0601P-G-P0019-001-00D	Process - DAF Float Sumps - Sheet 2 Of 2 - Process and Instrumentation Diagram
WP-P0020	1-0601P-G-P0020-001-00D	Process - DAF Sump Pumps - Process and Instrumentation Diagram
WR-E0111	1-0601R-A-E0111-001-00D	Electrical - Residuals Handling Area - First Floor Facility Plan
WR-E0112	1-0601R-A-E0112-001-00D	Electrical - Residuals Handling Area - First Floor Process Plan
WR-E0113	1-0601R-A-E0113-001-00D	Electrical - Residuals Handling Area - First Floor Power and Lighting Plan
WR-E0121	1-0601R-A-E0121-001-00D	Electrical - Residuals Handling Area - Second Floor Facility Plan
WR-E0122	1-0601R-A-E0122-001-00D	Electrical - Residuals Handling Area - Second Floor Process Plan
WR-E0123	1-0601R-A-E0123-001-00D	Electrical - Residuals Handling Area - Second Floor Power and Lighting Plan
WR-E0131	1-0601R-A-E0131-001-00D	Electrical - Residuals Handling Area - Third Floor Facility Plan
WR-E0132	1-0601R-A-E0132-001-00D	Electrical - Residuals Handling Area - Third Floor Process Plan
WR-E0133	1-0601R-A-E0133-001-00D	Electrical - Residuals Handling Area - Third Floor Power and Lighting Plan
WR-E0201	1-0601R-A-E0201-001-00D	Electrical - Residuals Handling Area - Stair Lighting
WR-E0401	1-0601R-A-E0401-001-00D	Electrical - Residuals Handling Area - Second Floor Process Plan
WR-H0112	1-0601R-A-H0112-001-00D	Plumbing - Residuals Area - First Floor Plan
WR-H0121	1-0601R-A-H0121-001-00D	HVAC - Residuals Handling Area - Second Floor Plan
WR-H0122	1-0601R-A-H0122-001-00D	Plumbing - Residuals Area - Second Floor Plan
WR-H0131	1-0601R-A-H0131-001-00D	HVAC - Residuals Handling Area - Third Floor Plan
WR-H0132	1-0601R-A-H0132-001-00D	Plumbing - Residuals Area - Third Floor Plan
WR-H0142	1-0601R-A-H0142-001-00D	Plumbing - Residuals Area - Roof Plan
WR-H9112	1-0601R-A-H9112-001-00D	Plumbing - Pipe Embeds - Residuals Area First Floor Plan
WR-H9122	1-0601R-A-H9122-001-00D	Plumbing - Pipe Embeds - Residuals Area Second Level Plan
WR-H9132	1-0601R-A-H9132-001-00D	Plumbing - Pipe Embeds - Residuals Area Third Floor Plan
WR-M0101	1-0601R-A-M0101-001-00D	Process Mechanical - Lower Level Plan
WR-M0111	1-0601R-A-M0111-001-00D	Process Mechanical - First Floor Plan
WR-M0112	1-0601R-A-M0112-001-00D	Process Mechanical - Inlet Channel - Plan
WR-M0113	1-0601R-A-M0113-001-00D	Process Mechanical - Washwater Recovery Tanks - Process Piping Plan
WR-M0121	1-0601R-A-M0121-001-00D	Process Mechanical - Second Floor Plan
WR-M0122	1-0601R-A-M0122-001-00D	Process Mechanical - Second Floor Plan - Gravity Thickeners

Consultant Drawing No.	City Drawing No.	Drawing Title
WR-M0123	1-0601R-A-M0123-001-00D	Process Mechanical - Second Floor Plan - Thickened Sludge Equalization Tanks
WR-M0124	1-0601R-A-M0124-001-00D	Process Mechanical - Flocculation Chamber - Plan
WR-M0201	1-0601R-A-M0201-001-00D	Process Mechanical - Sections and Details
WR-M0202	1-0601R-A-M0202-001-00D	Process Mechanical - Section
WR-M0203	1-0601R-A-M0203-001-00D	Process Mechanical - Section
WR-M0204	1-0601R-A-M0204-001-00D	Process Mechanical - Sections and Details
WR-M0205	1-0601R-A-M0205-001-00D	Process Mechanical - Section
WR-M0206	1-0601R-A-M0206-001-00D	Process Mechanical - Flocculation Chamber - Sections
WR-M0207	1-0601R-A-M0207-001-00D	Process Mechanical - Thickened Sludge Equalization Tanks - Sections
WR-M0208	1-0601R-A-M0208-001-00D	Process Mechanical - Thickener Sludge Extraction Pipe - Section
WR-M9112	1-0601R-A-M9112-001-00D	Pipe Embeds - Inlet Channel - Plan Views
WR-M9113	1-0601R-A-M9113-001-00D	Pipe Embeds - Washwater Recovery Tanks - Process Piping Plan
WR-M9123	1-0601R-A-M9123-001-01D	Pipe Embeds - Thickened Sludge Equalization Tanks - Plan Views
WR-M9124	1-0601R-A-M9124-001-00D	Pipe Embeds - Flocculation Chamber - Plan Views
WR-M9201	1-0601R-A-M9201-001-01D	Pipe Embeds - Sections
WR-M9202	1-0601R-A-M9202-001-00D	Pipe Embeds - Section
WR-M9206	1-0601R-A-M9206-001-00D	Pipe Embeds - Flocculation Chamber - Sections
WR-M9208	1-0601R-A-M9208-001-00D	Pipe Embeds - Thickened Sludge Extraction Pipe - Section
WR-P0001	1-0601R-G-P0001-001-00D	Process - Inlet Channel - Process and Instrumentation Diagram
WR-P0002	1-0601R-G-P0002-001-00D	Process - Washwater Recovery Tank 1 - Process and Instrumentation Diagram
WR-P0003	1-0601R-G-P0003-001-00D	Process - Washwater Recovery Tank 2 - Process and Instrumentation Diagram
WR-P0004	1-0601R-G-P0004-001-00D	Process - Washwater Recovery Tank 3 - Process and Instrumentation Diagram
WR-P0005	1-0601R-G-P0005-001-00D	Process - Washwater Recovery Tank 4 - Process and Instrumentation Diagram
WR-P0006	1-0601R-G-P0006-001-00D	Process - Washwater Recovery Tanks - Process and Instrumentation Diagram
WR-P0007	1-0601R-G-P0007-001-00D	Process - Supernatant Pump Station - Process and Instrumentation Diagram
WR-P0008	1-0601R-G-P0008-001-00D	Process - Gravity Thickener - Process and Instrumentation Diagram
WR-P0009	1-0601R-G-P0009-001-00D	Process - Thickened Sludge Equalization Tanks - Process and Instrumentation Diagram
WS-E0501	1-0601S-F-E0501-001-00D	Electrical - 600V Switchgear Single Line Diagram
WS-E0502	1-0601S-F-E0502-001-00D	Electrical - 600V Switchgear Elevation
WT-P001	1-0601T-G-P0001-001-05D	Process - Process and Instrumentation Diagram

E1.3 The following Specifications are applicable to the Work:

Specification No.	Title
Division 1	
01210	City Supplied Equipment
01300	Submittals
01400	Quality Control
01600	Material and Equipment
01650	Equipment Installation
01664	Training
01670	Commissioning
01730	Operation and Maintenance Manuals
Division 5	
05501	Weir Plates
Division 9	
09870	Coating Systems for Steel Tanks and Pipes
09901	Painting and Finishing -Process Mechanical

Specification No.	Title
Division 11	
11000	Equipment General Provisions
11001	Raw Water Pump Installation
11002	DAF System Installation
11003	Filter Media Installation
11004	Filter Underdrains Installation
11005	Filter Troughs Installation
11006	Ozone System Installation
11007	Large Butterfly Valve Installation
11008	Sluice Gate and Flap Gate Installation
11200	Mixers and Flocculators, General
11210	Vertical Shaft Flocculators
11251	Chemical Storage Tanks
11300	Process Pump General Requirements
11301	Process Motors
11305	Process Submersible Pumps
11308	Gear Pumps
11311	Horizontal, Split-Case Centrifugal Pumps
11316	Sampling Pumps
11320	Vertical Turbine Pumps
11321	Horizontal Screw Impeller Pumps
11330	Variable Speed Drives
11333	Submersible Screw Impeller Pumps
11346	Polymer Feed System
11352	Gravity Thickener Equipment
11374	Centrifugal Air Blower
11501	Vertical In-line Centrifugal Pumps
11505	Chemical Injection Nozzles
11901	Factory Applied Protective Coatings
Division 13	
13850	Fire Detection and Alarm
13930	Fire Suppression System
Division 14	
14620	Hoist and Monorail Systems
14630	Overhead Traveling Cranes
Division 15	
15010	General Mechanical Provisions
15060	Piping Support Systems
15085	Mechanical Thermal Insulation
15100-00	Plumbing Piping
15100-01	Data Sheet - Polyvinyl Chloride Drain Waste and Vent (PVC-DWV) Pipe and Fittings
15100-02	Data Sheet -Cast Iron Soil Pipe (CISP) and Fittings
15100-03	Data Sheet -Copper Drainage and Vent Pipe and Fittings
15100-10	Data Sheet -Galvanized Steel Drain and Vent Pipe and Fittings
15120	Hydronic Specialties
15120-01	Circulating Pump Schedule
15200-000	Process Piping
15200-00L	Piping Service Legend
15200-00S	Piping Schedule
15200-03	Data Sheet-Carbon Steel Pipe and Fittings-General Service
15200-04	Data Sheet-Carbon Steel Pipe and Fittings-Large Diameter
15200-07	Data Sheet-Galvanized Steel Pipe and Fittings-General Service
15200-08	Data Sheet-Stainless Steel Pipe and Fittings-General Service
15200-09	Data Sheet-Stainless Steel Pipe and Fittings-Special Service 1

Specification No.	Title
15200-10	Data Sheet-Polyvinyl Chloride (PVC) Pipe and Fittings
15200-12	Data Sheet-Fibreglass Reinforced Plastic (FRP) Pipe and Fittings
15200-13	Data Sheet-Copper and Copper Alloy Pipe, Tubing and Fittings
15200-14	Data Sheet-High Density Polyethylene (HDPE) Pipe And Fittings
15200-19	Data Sheet-Stainless Steel Pipe and Fittings-Special Service 2
15200-20	Data Sheet-Stainless Steel Pipe and Fittings-Special Service 3
15200-21	Data Sheet-Carbon Steel Pipe and Fittings-Natural Gas Service
15202	Process Valves and Operators
15202-01	Automated Valve Schedule
15202-02	Manual Valve Schedule
15205	Piping Specialties
15410	Plumbing Fixtures
15440	Plumbing Equipment
15500	Heat Generation
15710	Heat Transfer
15720	Air Handling
15720-01	Heat Recovery Unit (HRU) Schedule
15720-02	Gas Fired Make-up Air Unit (MAU) Schedule
15720-03	Air Handling Unit (AHU) Schedule
15730	Unitary Air-Conditioning Equipment
15730-01	Water Source Heat Pump (HP) Schedule 1 of 2
15730-02	Water Source Heat Pump (HP) Schedule 2 of 2
15760	Terminal Heat Transfer Units
15760-01	Gas Fired Unit Heater (GUH) Schedule
15760-02	Electric Unit Heater (EUH) Schedule
15760-03	Electric Radiant Heater (ERH) Schedule
15760-04	Electric Convectors (EC) Schedule
15810	Metal Ductwork and Accessories
15810-01	Ductwork Schedule
15810-02	Cross Talk Silencer (XT) Schedule
15810-03	Duct Silencer Schedule
15815	Fibreglass Reinforced Plastic (FRP) Ductwork and Accessories
15830	Fans
15830-01	Exhaust Fan (EF) Schedule
15830-02	Roof Gravity Vent (GV) Schedule
15850	Air Outlets and Inlets
15900	HVAC Instrumentation and Controls -General
15900-01	Typical Control Sequences
15900-02	MAU-H001, EF-H002, EF-H003, EF-H004 Filter Galleries - Heating and Ventilation System
15900-03	MAU-H011, EF-H013 Pilot Plant Room - Heating and Ventilation System
15900-04	MAU-H012, EF-H014 Washwater Recovery Gallery - Heating and Ventilation System
15900-05	MAU-H021, EF-H023 Ozone Generator Room - Emergency Ventilation System
15900-06	MAU-H031, EF-H037 Polymer Feed & Storage Area - Heating and Ventilation System
15900-07	MAU-H032, EF-H038 Peroxide Feed & Storage Room - Heating and Ventilation System
15900-08	MAU-H033, EF-H039 SBS Feed & Storage Room - Heating and Ventilation System
15900-09	MAU-H051, EF-H052, EF-H053 DAF Process Gallery - Heating and Ventilation System
15900-10	AHU-H035 Electrical Room No. 2 - Ventilation and Cooling System
15900-11	AHU-H061 Raw Water Pump Room - Cooling and Ventilation System
15900-12	AHU-H062 Electrical Room No. 1 - Ventilation and Cooling System
15900-13	AHU-071, EF-H075, EF-H076 Administration Area - Ventilation Air Supply
15900-14	HRU-H022, EF-H024, EF-H025 Ozone Generator Room - Heating and Ventilation System

Specification No.	Title
15900-15	HRU-H034 Maintenance Workshop Area - Heating and Ventilation System
15900-16	Water Source Heat Pumps (WSHP) - Heating & Air Conditioning Controls
15900-17	HWP-H007, HWP-H008, HWP-H016, HWP-H017 Condenser Water System
15900-18	EF-H005, EF-H006, EF-H040, EF-H044 Simple Exhaust Fans - Control System
15900-19	EF-H015 Mechanical Room No. 2 - Heat Relief Ventilation System
15900-20	EF-H041 Mechanical Room No. 3 - Heat Relief Ventilation System
15900-21	EF-H043 Maintenance Workshop Area - Sanitary Exhaust System
15900-22	EF-H063 AND EF-H065 Fire Pump Room - General and Heat Relief Ventilation System
15900-23	EF-H064 Mechanical Room No. 1 - Heat Relief Ventilation System
15900-24	EF-H073 Administration Area - Sanitary Exhaust System
15900-25	EF-H074 Mechanical Room No. 4 - Heat Relief Ventilation System
15900-26	EF-H067 Administration Area Electrical Closet - Heat Relief Ventilation System
15900-27	Electric Radiant Heaters (ERH) Air Intake Birdscreen Defrosting System
15901	HVAC Controls, Field Components, and Instruments
15901-01	Motorized Damper (MD) Schedule
15902	Microelectronic Control Components
15950	HVAC Systems Testing, Adjusting, and Balancing
Division 16	
16010	Electrical General Requirements
16030	Electrical Testing
16106	Installation of Cables in Trenches and in Ducts
16111	Conduits, Conduit Fastenings and Conduit Fittings
16114	Cable trays
16115	Busways
16116	Wireways and Auxiliary Gutters
16123	Communications Conductors
16124	System Cables
16125	Wires, Cables and Hardware up to 1000 V
16131	Splitters, Junction Boxes, Pull Boxes and Cabinets
16132	Outlet Boxes, Conduit Boxes and Fittings
16141	Wiring Devices
16151	Wire and Box Connectors 0 -1000 V
16153	Connectors and Terminations
16160	Grounding
16191	Fastenings and Supports
16321	Distribution Transformers -Liquid Cooled
16323	Pad Mounted Distribution Transformers
16341	Primary Lightning Arresters
16359	Interlock Systems
16426	Secondary Switchgear
16430	Distribution Panelboards
16431	Metering and Switchboard Instruments
16432	Instrument Transformers
16440	Disconnect Switches - Fused and Non-Fused up to 600 V Primary
16450	Grounding -Secondary
16461	Dry Type Transformers up to 600 V Primary
16471	Panelboards -Breaker Type
16476	Air Circuit Breakers
16477	Moulded Case Circuit Breakers
16480	Power Surge Protectors
16485	Contactors
16500	General Provisions for Interior Lighting
16505	Lighting Equipment
16519	Exit Signs
16536	Unit Equipment for Emergency Lighting

Specification No.	Title
16610	Uninterruptible Power Systems Static
16723	Multiplex Fire Alarm System
16741	Telecommunications Raceway System
16811	Motor Starters to 600 V
16814	Low Voltage Soft Starters 600 V
16815	Variable Frequency Drives
16820	Motor Control Centre
16825	Control Devices
16903	Cable Schedules
16903-01	Power Cable Schedule
16903-02	Control Cable Schedule
16950	Connections to Mechanical Equipment
16960	Starting of Electrical Equipment and System
16980	Testing, Adjusting and Balancing of Electrical Equipment and Systems
16990	Electrical Equipment and Systems Demonstrations and Instruction
16991	Control Panels
Division 17	
17010	Instrumentation and Control General Requirements
17015	Scope of Instrumentation and Control Work
17110	Enclosures
17124	Instrumentation Cable
17130	Power Supplies
17140	Instrument Air Supply and Transmission
17211	Process Taps and Primary Elements
17212	Transmitters and Indicators
17216	Switches and Relays
17271	Signal Conditioning Modules
17274	Panel Instruments
17275	Miscellaneous Panel Devices
17300	Gas Detection Systems
17500	Programmable Logic Controllers
17501	Operator Interface Requirements
17600	PLC I/O Index
17600-A	PLC I/O Index
17700	Instrument Index
17700-A	Instrument Index
17701	Instrument Specification Sheets
17701-A	Instrument Specification Sheets
17702	Instrument Loop Drawings
17704	Instrument Standard Details
Appendix A	Vendor List for Instrumentation and Control Devices

GENERAL REQUIREMENTS

E2. OFFICE AND SITE FACILITIES

E2.1 The Contractor shall supply office facilities for his own use. The facilities shall be situated at the area designated on CM-G001.

E2.2 With reference to drawing CM-G001, the City will provide to the Contractor without cost:

(a) Granular pad for office location

(b) A 100A two pole breaker in Distribution A to serve office lighting, receptacles and convenience power (electric space heating equipment is not allowed)

(c) Communications connections for four telephone and internet (high speed equivalent). The Contractor shall supply and install the telephone service from the City's existing telephone service pedestal that is located in the contractor's office area.

(d) Onsite washroom and toilet facilities with non-potable water supply

(e) Power for construction purposes:

(i) Unless otherwise specified, all required over-current protection, portable distribution panels and transformations, cables, conductors, grounding and other materials required to provide construction power for the Work shall be supplied and installed by the Contractor.

(ii) Distributions 1, 2 and 3 as shown on CM-G001 are available for the Contractor's use from September 30, 2006 until Substantial Performance.

(iii) Manitoba Hydro utility charges for electrical power used by the Contractor for construction purposes will be paid by the City.

(iv) Power required for on Site welding shall be provided by the Contractor.

E2.3 The Contractor may arrange for additional facilities with the approval of the Contract Administrator and at the Contractor's cost.

E3. SITE ROADS AND WORK SITE ACCESS

E3.1 The Contractor shall have access to the Site on Business Days between 07:00 and 18:00 unless otherwise approved by the Contract Administrator.

E3.2 Access to the work site is restricted and cooperation with other contractors on site is necessary in the best interest of all parties.

E3.3 The Site is located on Provincial Road 207, 3.2 km north of Highway 1 in Dugald, Manitoba.

E3.3.1 The Site address is PR 207, Lot 57082, Dugald, Manitoba.

E3.3.2 Provincial Road 207 is a Class B1 road and is subject to load restrictions which will affect the maximum weight of individual deliveries. However, The City of Winnipeg and Manitoba Transportation and Government Services (TGS) have reached the following agreement to facilitate construction of the Winnipeg Water Treatment Program:

(a) The approximately 3.2 km of PR 207 between the entrance to the Site and Highway 1 will be designated as an TAC Route for construction of the Winnipeg Water Treatment Program effective January 1, 2006 until TGS imposes Spring Restrictions.

(b) During the TGS imposed Spring Restriction period, normal (non Spring Restriction) Class B1 highway loadings will be allowed on PR 207 between the entrance to the Site and Highway 1. The Spring Restriction period is normally in place from March 23 to May 26, but it is subject to change due to weather conditions as assessed by TGS. Upon removal of the Spring Restriction, normal Class B1 will continue to be allowed.

(c) The portion of PR 207 between the entrance to the Site and Highway 1 will be upgraded during 2006 to a TAC Route. PR 207 will remain open during the upgrading process but users will be subjected to intermittent delays due to road construction.

(d) TGS permits will be required for each construction vehicle in excess of Class BI highway loading from January 1, 2006 until the upgrade of PR 207 has been completed:

(i) The Contract Administrator will provide permit forms to the Contractor.

(ii) The Contractor shall complete a permit form for each company retained to transport materials to the Site and shall return them to the Contract Administrator who will submit the permit forms to TGS for processing.

(iii) The Contract Administrator will return the completed permit forms to the Contractor and the Contractor shall ensure that each vehicle carries a photocopy of the permit.

(iv) The permit fee will be paid directly to TGS by the City of Winnipeg. The Contractor will not be charged for the permit fees.

(v) The permit will be good for 1 year from issue.

(vi) The Contract Administrator will establish a process to record the date, company name and commodity of each vehicle entering the Site.

(vii) TGS will make random permit checks of vehicles using PR 207.

E3.4 Access to the Site is generally limited to

(a) A temporary bridge over the Aqueduct adjacent to the Project offices. Use of this bridge has restrictions for the period of time that the yard piping and Raw Water Pumping Station construction is under way – this bridge is scheduled to be removed October 31/06

(b) A temporary bridge over the Aqueduct east of the Manitoba Hydro tower– this bridge is scheduled to be removed October 31/06. A permanent bridge adjacent to this bridge will be installed during the summer of 2006 and will be available for use upon completion.

(c) Access from west of the Clearwell. Use of this access is subject to completion of clearwell backfill expected to be complete mid summer 2006.

E3.5 On site access roads will be installed by others as follows:

(a) From temporary bridge noted in E3.4 above to a location adjacent to the RWPS

(b) From temporary / permanent bridge noted in E3.4 above to

- to a location adjacent to the RWPS at approximately elevation 234.0
- to a location at the top of the excavation generally east of the filtration area

E4.4 Maintenance and upkeep of the noted roads is the shared responsibility of all contractors who use the roads, including the Contractor.

E3.6 Construction and removal, if necessary, of any additional access roads is the responsibility of this Contractor.

E4. WASTE CONTAINER

E4.1 A waste container to dispose of garbage produced from the site shall be provided by the Contractor. It shall be located in a safe, convenient location, and be emptied as necessary by the Contractor. The provision, maintenance and removal of a waste container shall be considered a subsidiary obligation of the Contractor

E5. CONDITION, PROTECTION OF, AND ACCESS TO THE AQUEDUCT

E5.1 Condition of the Aqueduct

E5.1.1 The Aqueduct is constructed of reinforced concrete and in some areas, contains numerous cracks. The Aqueduct, therefore, shall be considered as a fragile structure. All work procedures conducted by the Contractor on and/or near the Aqueduct shall be well planned and executed to ensure that the Aqueduct is not subjected to construction

related loads, including excessive vibrations and concentrated or asymmetrical lateral loads.

E5.2 Protection of the Aqueduct

E5.2.1 Contractors working in the vicinity of the aqueduct shall ensure that:

(a) Equipment shall only be permitted to cross the Aqueduct at designated bridge crossing locations and shall come to a complete stop before crossing.

(b) Granular material, construction material, soil or other material shall not be stockpiled on the Aqueduct or within 10 metres of the Aqueduct centreline.

(c) Construction practices shall not subject the Aqueduct arch to asymmetrical loading at any time.

(d) Construction practices or procedures at or near the Aqueduct shall not impart excessive vibration loads on the Aqueduct and/or cause settlement of the subgrade below the Aqueduct.

E5.2.2 It is the Contractors' responsibility to ensure that all work crew members understand, observe, and work to the requirements of Specifications.

E5.3 Equipment Restrictions

E5.3.1 Equipment must cross the Aqueduct in a responsible and careful manner (i.e. slowly).

E5.3.2 Loads for Highway No. 207 shall be limited to the weight restrictions in place for the road unless otherwise permitted.

E6. ENVIRONMENTAL PROTECTION

E6.1 The Contractor shall be aware that the Aqueduct is for potable water supply and no contamination by fuel, chemicals, etc. shall be permitted at any time. Fuels or chemicals shall not be stored within 30 metres of the Aqueduct.

E6.2 The Contractor shall plan and implement the Work of this Contract strictly in accordance with the requirements of the environmental protection measures as herein specified.

E6.3 The Contractor is advised that at least the following Acts, Regulations, and By-laws apply to the Work:

E6.3.1 Federal

(a) Canadian Environmental Protection Act (CEPA) c.16

(b) Transportation of Dangerous Goods Act and Regulations c.34

E6.3.2 Provincial

(a) The Dangerous Goods Handling and Transportation Act D12

(b) The Endangered Species Act E111

(c) The Environment Act c.E125

(d) The Fire Prevention Act F80

(e) The Manitoba Nuisance Act N120

(f) The Public Health Act c.P210

(g) The Workplace Safety and Health Act W120

(h) Current applicable associated regulations.

(i) The Fisheries Act

(j) The Migratory Birds Act

(k) The Historic Resources Act

(l) Drinking Water Safety Act

E6.3.3 The Contractor is advised that the following environmental protection measures apply to the Work.

E6.3.4 Materials Handling and Storage

(a) Construction materials shall not be stored within ten (10) metres of the Aqueduct centerline without the approval of the Contract Administrator.

E6.3.5 Fuel Handling and Storage

(a) The Contractor shall abide by the requirements of Manitoba Conservation storage and handling of Petroleum Products and Allied Products Regulations for handling and storage of fuel products.

(b) All fuel handling and storage facilities shall comply with The Dangerous Goods and Transportation Act Storage and Handling of Petroleum Products Regulation and any local land use permits.

(c) Fuels, lubricants, and other potentially hazardous materials as defined in The Dangerous Goods and Transportation Act shall be stored and handled within the approved storage areas.

(d) The Contractor shall ensure that all fuel storage containers are inspected daily for leaks and spillage.

(e) Products transferred from the fuel storage area(s) to specific work sites shall not exceed the daily usage requirement.

(f) When servicing requires the drainage or pumping of fuels, lubricating oils or other fluids from equipment, a groundsheet of suitable material (such as HDPE) and size shall be spread on the ground to catch the fluid in the event of a leak or spill. No repairs within 30 m of aqueduct or watercourse will be permitted.

(g) Refuelling of mobile equipment and vehicles shall take place at least 30 m from a watercourse.

(h) The area around storage sites and fuel lines shall be distinctly marked and kept clear of snow and debris to allow for routine inspection and leak detection.

(i) A sufficient supply of materials, such as absorbent material and plastic oil booms, to clean up minor spills shall be stored nearby on-site. The Contractor shall ensure that additional material can be made available on short notice. All refuelling vehicles shall be equipped with a spill response kit.

E6.3.6 Waste Handling and Disposal

(a) The construction area shall be kept clean and orderly at all times during and at completion of construction.

(b) At no time during construction shall personal or construction waste be permitted to accumulate for more than one day at any location on the construction site, other than at a dedicated storage area as may be approved by the Contract Administrator.

(c) Indiscriminate dumping, littering, or abandonment shall not take place.

(d) No on-site burning of waste is permitted.

(e) Equipment shall not be cleaned within 30 m of watercourses; contaminated water from onshore cleaning operations shall not be permitted to enter watercourses.

E6.3.7 Dangerous Goods/Hazardous Waste Handling and Disposal

(a) Dangerous goods/hazardous waste are identified by, and shall be handled according to, The Dangerous Goods Handling and Transportation Act and Regulations.

(b) The Contractor shall be familiar with The Dangerous Goods Handling and Transportation Act and Regulations and meet training requirements for these Regulations.

E6.3.8 Emergency Spill Response

(a) The Contractor shall ensure that due care and caution is taken to prevent spills.

(b) The Contractor shall report all major spills of petroleum products or other hazardous substances with the potential for impacting the environment and threat to human health and safety to the Contract Administrator and Manitoba Conservation, immediately after occurrence of the environmental accident, by calling the 24-hour emergency telephone phone number (204) 945-4888.

(c) The Contractor shall designate a qualified supervisor as the on-site emergency response coordinator for the project. The emergency response coordinator shall have the authority to redirect manpower in order to respond in the event of a spill. (Should include reference to a site-specific Emergency Response Plan and Environmental Protection Plan.)

(d) The following actions shall be taken by the person in charge of the spilled material or the first person(s) arriving at the scene of a hazardous material accident or the on-site emergency response coordinator:

(i) Notify emergency-response coordinator of the accident:

- identify exact location and time of accident
- indicate injuries, if any
- request assistance as required by magnitude of accident Manitoba Conservation 24-hour Spill Response Line (204) 945-4888, RCMP (Oakbank Detachment) (911), City of Winnipeg Fire Department (911), Springfield Ambulance (911), company backup, contact Contract Administrator.

(ii) Assess situation and gather information on the status of the situation, noting:

- personnel on site
- cause and effect of spill
- estimated extent of damage
- amount and type of material involved
- proximity to waterways and the Aqueduct

(iii) If safe to do so, try to stop the dispersion or flow of spill material:

- approach from upwind
- stop or reduce leak if safe to do so
- dyke spill material with dry, inert sorbent material or dry clay soil or sand
- prevent spill material from entering waterways and utilities by dyking
- prevent spill material from entering Aqueduct manholes and other openings by covering with rubber spill mats or dyking

(iv) Resume any effective action to contain, clean up, or stop the flow of the spilled product.

E6.4 The emergency response coordinator shall ensure that all environmental accidents involving contaminants shall be documented and reported to the Manitoba Conservation according to The Dangerous Goods Handling and Transportation Act Environmental Accident Report Regulation 439/87.

E7. SITE RESTORATION

E7.1 The Contractor shall remove the temporary Site office and storage facilities prior to the Certificate of Total Performance being issued.

E7.2 The Contractor will be responsible for grounds restoration, as determined necessary by the Contract Administrator.

E7.3 The Contractor will be responsible for any damage caused by his forces on roadways or accesses.

E8. CONCRETE EMBEDS AND SLEEVES

E8.1 Piping and conduit required for the performance of the Work must pass through cast-in-place concrete walls and slabs. The cast-in-place concrete will be supplied and installed by a concrete placement contractor retained by the City under a separate contract. The concrete placement contractor will be the Installer of certain embeds as specified herein.

E8.2 Mechanical Embeds in the Filtration Area:

E8.2.1 All mechanical wall embeds, sleeves and concrete encased piping within the area bounded by gridlines BA to BD and gridlines B2 to B18 shall be supplied and installed by the concrete placement contractor. All other mechanical wall embeds shall be supplied by the Contractor and installed by the concrete placement contractor.

E8.2.2 Mechanical embeds, sleeves and concrete encased piping at gridlines BA, BD and B2:

(a) All mechanical wall embeds and sleeves that cross gridlines BA, BD and B2 will be supplied and installed by the concrete placement contractor.

(b) All slab concrete encased piping that crosses gridline BD will be terminated 1m south of gridline BD by the concrete placement contractor.

E8.3 The location of all mechanical and electrical embeds shall be generally as shown on the Drawings, however, final locations of all mechanical and electrical embeds shall be determined by the Contractor and shall be shown on pipe placement Shop Drawings prepared by the Contractor.

E8.4 The Contract Administrator will provide the Contractor with a concrete placement schedule at least 20 Business Days prior the start of formwork for any concrete wall or slab. The Contractor shall provide the Contract Administrator with pipe placement Shop Drawings a minimum of 5 Business Days prior to start of any formwork in which an embed or sleeve is required so the Contract Administrator can coordinate this work with the Installation Contractor.

E8.5 Wall embeds and sleeves:

E8.5.1 Except as specified in E8.2, the Contractor responsible for the supply and installation of piping as specified in Divisions 11 and 15 shall supply all wall embeds and sleeves required to perform this portion of the Work. The concrete placement contractor will install the wall embeds and sleeves required for each concrete placement.

E8.5.2 The Contractor responsible for Division 16 and 17 shall supply and install all wall embeds and sleeves required to perform this portion of the Work.

E8.6 Slab embeds and concrete encased piping:

E8.6.1 Except as specified in E8.2, mechanical and electrical slab embeds, sleeves and concrete encased piping shall be supplied and installed by the Contractor.

E8.7 Anchors in housekeeping pads for equipment mounting:

E8.7.1 The Contractor shall locate all housekeeping pads and supply and install all anchors in all concrete pads as required to mount equipment installed by him. Concrete housekeeping pads shall be supplied and installed by the concrete placement contractor. This requirement includes the mounting of equipment within the area specified in E8.2 above.

E8.8 Embeds in cast-in-place concrete for monorails and cranes:

E8.8.1 The Contractor responsible for the supply and installation of monorails and cranes as specified in Division 14 shall supply all embeds required to install this portion of the Work and locate them for the concrete placement contractor. The concrete placement contractor will install the embeds for the cranes and monorails.

E9. NOT USED

E10. RECORD DRAWINGS

E10.1 The Contractor shall keep one (1) complete set of white prints at their Site office, including all Addenda, Change Orders, Field Instructions, and other revisions for the purposes of Record Drawings. As the Work proceeds, the Contractor shall clearly record in red pencil all as-built conditions which deviate from the original Contract documents.

E10.2 The Record Drawings shall be available for review by the Contract Administrator upon request at any time during the performance of the Work.

E10.3 Prior to achieving Substantial Performance, the Contractor shall submit the Record Drawings prepared to the Contract Administrator for his review and use. If, in the opinion of the Contract Administrator, the Record Drawings are incomplete or inaccurate, the Record Drawings will be returned to the Contractor and the Contractor shall revise and resubmit the Record Drawings at his cost.

E10.4 Substantial Performance cannot be achieved without the submission of Record Drawings that are acceptable to the Contract Administrator

CITY SUPPLIED EQUIPMENT

1. GENERAL

.1 The City has entered into a number of equipment supply contracts based on the Bid Opportunities described in Part D. Installation of City Supplied Equipment is the responsibility of this Contractor.

.2 The City Supplied Equipment will be delivered to and stored at the City Warehouse. The Contractor shall offload and accept equipment delivery. The cost for pick-up and delivery of equipment from the City's Warehouse to the jobsite will be borne by the Contractor.

.3 The Contractor shall be responsible for all equipment at the City Warehouse.

.4 The Contractor shall ensure that he is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage including any required maintenance.

.5 All forms referred to in this Section (Form 100, 101, 102 and 103) will be initiated by the Supply Contractor to be completed by the Contractor as detailed below.

.6 Prior to accepting any of the equipment to be supplied by a Supply Contractor, the Contractor shall inspect the equipment. A representative from each of the following groups will be in attendance at the time of pick-up and delivery: the Supply Contractor, Contractor, and Contract Administrator. A duly executed *Form 100 – Certificate of Equipment Delivery* shall be completed. Any minor damage identified during the inspection shall be repaired as per the Supply Contractor's instructions at the Supply Contractor's cost. Any severe damage will be grounds for rejection of the equipment. The severely damaged equipment will be replaced at the Supply Contractor's cost. The Contractor shall accept the equipment and assume risk and responsibility for the equipment and fill out *Form 100 - Certificate of Equipment Delivery.*

.7 If the Contractor's inspection reveals any deficiencies in the equipment, then these shall be noted in writing prior to the Contractor accepting the equipment. Only deficiencies noted and documented in the foregoing manner will be deemed not the responsibility of the Contractor.

.8 The Contractor shall be responsible for the installation of City Supplied Equipment in addition to all equipment supplied under this Contract. City Supplied Equipment shall be installed in accordance with the Supply Contractor's installation instructions.

.9 For the purposes of Form 100, the Supply Contractor will be the Manufacturer.

2. SUPERVISION OF INSTALLATION, START-UP, COMMISSIONING, AND FIELD TESTING

.1 For City Supplied Equipment, each Supply Contractor will provide the services of a qualified representative to assist in the installation, start-up, and performance testing of all of the equipment. The Contractor shall refer to Sections 01650 – Equipment Installation,

CITY SUPPLIED EQUIPMENT

Section 01670 – Commissioning, and Divisions 11, 13, 15, 16, and 17 for details on the services and procedures not included in this Section. The services to be performed by the Supply Contractors are as follows:

.1 Prior to the Contractor beginning the installation, the Supply Contractor will provide to the Contractor instructions and advice regarding the detailed requirements for the equipment installation. The Supply Contractor will be required to provide a *Certificate of Readiness to Install, Form 101*. The Contractor shall be required to sign Form 101 to acknowledge that he has received adequate instruction. During installation, if the Contractor has additional questions regarding installation requirements or procedures, he shall contact the Supply Contractor, with the assistance of the Contract Administrator, as required. No additional compensation to the Contractor based on claims of inadequate training from a Supply Contractor will be entertained should he install equipment improperly.

.2 Following the completion of the installation, the Supply Contractor will inspect the installation of the equipment to verify that it has been installed in accordance with the Supply Contractor's requirements. The Supply Contractor will be required to provide a *Certificate of Satisfactory Installation, Form 102*. If any deficiencies in the installation exist at the time of inspection, these shall be noted on Form 102 by the Supply Contractor. The Contractor shall be responsible for the prompt correction of these deficiencies prior to performance testing of the equipment.

.3 The Supply Contractor shall assist the Contractor in Performance Verification of the equipment. Commissioning is to conform to the requirements in Section 01670 and Divisions 11, 13, 14, 15, 16, and 17.

.4 The Supply Contractors for City Supplied Equipment have been contracted to provide site visits for inspection of installation and for assistance of Performance Verification.

.2 The Contract Administrator will be responsible for the Project Master Schedule and will coordinate the services to be provided. The Contract Administrator will provide the Contractor at least twenty one (21) days advance notice of when the Supply Contractor's services will be provided.

3. OPERATION AND PERFORMANCE VERIFICATION

.1 Equipment shall be subjected to a demonstration, running test, and performance tests after the installation has been verified and any identified deficiencies have been remedied.

.2 Inform the Contract Administrator at least twenty one (21) days in advance of conducting the tests and arrange for the attendance of the Supply Contractor. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Contract Administrator.

CITY SUPPLIED EQUIPMENT

.3 The Supply Contractor will conduct all necessary checks to equipment and if necessary, advise the Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.

.4 The Contractor shall then operate the equipment for at least one (1) hour to demonstrate to himself the operation of the equipment and any required ancillary services. Any remedial measures required to ensure satisfactory operation shall be promptly undertaken.

.5 Demonstration:

.1 The Contractor shall notify the Contract Administrator of his readiness to demonstrate the operation of the equipment. The Contract Administrator shall attend, as expeditiously as possible.

.2 With the assistance of the Supply Contractor, the Contractor shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will be checked and if appropriate, code certifications provided.

.3 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., will be checked to ensure that they are within the specified or Supply Contractor's recommended limits, whichever is more stringent.

.4 On satisfactory completion of the one (1) hour demonstration, the equipment shall be stopped and critical parameters, such as alignment, shall be rechecked.

.6 Running Test:

.1 The equipment shall be restarted and run continuously for a minimum of three (3) days (72 hours) or as specified. During this period, as practicable, conditions shall be simulated which represent maximum or most severe, average, and minimum or least severe conditions. These conditions will be mutually agreed by the Supply Contractor, the Contractor, and Contract Administrator on the basis of the information contained in the technical specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.

.7 Performance Tests:

.1 Performance tests shall be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Contract Administrator, the Supply Contractor, and the Contractor.

.2 The equipment shall be run continuously for a minimum of seven (7) days (168 hours) or as specified.

CITY SUPPLIED EQUIPMENT

.3 Performance tests shall be as dictated in the technical specifications for each item of equipment or as reasonably required by the Contract Administrator to prove adherence to the requirements listed in the specification.

.4 The Contractor shall submit the results of the performance tests within 24 hours to the Contract Administrator, and final documented and summarized results in a format acceptable to the Contract Administrator within 7 calendar days. The Contract Administrator reserves the right to request additional testing. No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the performance test(s) and receipt of the test reports.

.8 All water, chemicals, temporary power (except portable generators), heating, or any other ancillary services required to complete the initial demonstration, running test and performance tests are the responsibility of the City.

.9 Should the initial demonstration, running test or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and / or performance tests shall be repeated to the satisfaction of the Contract Administrator. Additional costs incurred by the Contractor, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor or Supply Contractor as determined by the Contract Administrator.

.10 On successful completion of the demonstration, running test, and performance tests, *Form 103 – Certificate of Equipment Satisfactory Performance* attached to Section 01650 will be signed by the Supply Contractor, the Contractor, and the Contract Administrator.

.11 The Contractor shall affix to the tested equipment a 100 mm by 200 mm card reading "Operable Condition - Do Not Operate without Contractor's Permission." stenciled on in large black letters.

END OF SECTION

SUBMITTALS

1. SHOP DRAWINGS

1.1 General

.1 Arrange for the preparation of clearly identified Shop Drawings as specified or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate materials, methods of construction, and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design Drawings and Specifications. Notify the Contract Administrator of any deviations in Shop Drawings from the requirements of the Contract Documents to allow the Contract Administrator to assess the deviations.

.2 Where all or part of the Shop Drawings are to be prepared under the stamp and seal of a Professional Engineer registered in the Province of Manitoba, the Contract Administrator will limit that review to an assessment of the completeness of the part of the submission so stamped and sealed.

1.2 Electrical and Controls Installation Information

.1 Key information will be taken from Shop Drawings to prepare electrical and instrumentation Drawings and/or layout Drawings, control schematics, and interconnection wiring diagrams.

1.3 Submission Requirements

.1 Coordinate each submission with requirements of the Work and Contract Documents. Individual submissions will not be reviewed until all related information is available.

.2 Accompany all submissions with a transmittal letter, in duplicate, containing:

.1 Date

.2 Project title and Bid Opportunity number

.3 Contractor's name and address

.4 Specification Section number for each submittal

.5 Submittal number and revision number in the following format:

.1 742 - Spec Section # - Submittal # - Revision # (e.g. 742-15200-001-1).

.2 The first submittal is numbered 1 with sequential numbering after that for revisions.

.6 Identification and quantity of each Shop Drawing product

.7 Equipment tag number

.8 Other pertinent data

.3 Submissions shall include:

.1 Date and revision dates

.2 Project title and number

.3 Name, email address and address of:

.1 Contractor

.2 Manufacturer

.4 Contractor's stamp, signed by Contractor's authorized representative, certifying approval of submissions, verification of field measurements and compliance with Contract Documents.

.5 As required in the specifications, the seal and signature of a Professional Engineer registered in the Province of Manitoba.

.4 Details of appropriate portions of work as applicable:

.1 Fabrication

.2 Layout showing dimensions including identified field dimensions and clearances

.3 Setting or erection details

.4 Capacities

.5 Performance characteristics

.6 Standards

.7 Operating weight

.8 Wiring diagrams

.9 Single line and schematic diagrams

.10 Method of control of equipment and its communication with the City’s SCADA system

1.4 Drawings

.1 Original Drawings or modified standard Drawings provided by the Contractor to illustrate details of portions of Work which are specific to project requirements.

.2 Maximum sheet size: 850 x 1050 mm.

.3 Submit twelve (12) prints and one (1) reproducible copy of Shop Drawings. The Contract Administrator will return the reproducible copy with comments transcribed.

.4 Cross-reference Shop Drawing information to applicable portions of the Contract Documents.

.5 Include reviewed Shop Drawings in all O&M Manuals.

1.5 Product Data

.1 Product Data; Manufacturer's catalogue sheets, brochures, literature, performance charts, and diagrams used to illustrate standard manufactured products.

.2 Submit twelve (12) copies of product data.

.3 Sheet size: 215 x 280 mm.

1.6 Procedure and Routing

.1 The Contractor shall provide to the Contract Administrator thirteen (13) printed copies of the Shop Drawings and corresponding submittal transmittal form(s) complete with the information specified in 1.3 Submission Requirements.

.2 The Contractor shall simultaneously email the .pdf version of these same Shop Drawings and submittal transmittal forms to the Contract Administrator. The Contractor shall ensure the .pdf version of the Shop Drawings and corresponding submittal transmittal form(s) are identical to the printed copies being distributed for review. When the total size of the email is greater than 5 MB, the Contractor shall post the .pdf version of the Shop Drawings and submittal transmittal form(s) to an accessible place on the internet (provided by the Contract Administrator) and an e-mail notification is to be sent to all parties listed above when posting is complete.

.3 The routing and the names of individuals responsible for receiving submittals will be identified by the Contract Administrator at the pre-construction meeting held pursuant to D4.2.

.4 Upon review of the Shop Drawings, the Contract Administrator will e-mail the .pdf version of the annotated Shop Drawings and corresponding transmittal form(s) to the Contractor. When the total size of the email is greater than 5 MB, the Contract Administrator will post the .pdf version of the Shop Drawings and corresponding transmittal form(s) to the same accessible place on the internet and an e-mail notification will be sent to the Contractor. Two (2) printed copies of the reviewed Shop Drawings will be sent back to the Contractor.

1.7 Shop Drawing Review

.1 Shop Drawing review by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for the approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.2 Review by the Contract Administrator shall not relieve the Contractor of his responsibility for errors or omissions in Shop Drawings or for proper completion of the Work in accordance with the Contract Documents.

.3 Shop Drawings will be returned to the Contractor with one of the following notations:

.1 When stamped "REVIEWED", distribute additional copies as required for execution of the Work.

.2 When stamped "REVIEWED AS MODIFIED", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".

.3 When stamped "REVISE AND RE-SUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.

.4 When stamped "NOT REVIEWED", submit other drawings, brochures, etc., for review consistent with the Contract Documents.

.5 Only Shop Drawings bearing "REVIEWED" or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.

.4 After submittals are stamped "REVIEWED" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.

.5 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.

.6 Make changes in Shop Drawings which the Contract Administrator may require consistent with Contract Documents. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.

.7 Shop Drawings indicating design requirements not included in the Contract Documents require the seal of a Professional Engineer registered in the Province of Manitoba. If requested, submit engineering calculations for review, sealed by a Professional Engineer.

1.8 Operating and Maintenance Manuals

.1 Refer to Section 01730 – Operations and Maintenance Manuals.

END OF SECTION

QUALITY CONTROL

1. CODES AND STANDARDS

.1 In the case of a conflict or discrepancy between the Contract Documents and the governing standards, the more stringent requirements shall apply.

.2 Unless the edition number and date are specified, the reference to the Manufacturer's and published codes, standards, and Specifications are to be the latest edition published by the issuing authority, current at the date of Submission Deadline.

.3 Reference standards and Specifications are quoted in this Specification to establish minimum standards. Work in quality exceeding these minimum standards conforms to the Contract.

.4 Where reference is made to a Manufacturer's direction, instruction, or Specification, it is deemed to include full information on storing, handling, preparing, mixing, installing, erecting, applying, or other matters concerning the Products pertinent to their use and their relationship to the Products with which they are incorporated.

.5 Confine apparatus, the storage of Products, and the operations of workers to limits indicated by laws, ordinances, permits, and by directions of the Contract Administrator. Do not unreasonably encumber the premises with Products.

.6 Where reference is made to regulatory authorities, it includes all authorities who have, within their constituted powers, the right to enforce the laws of the Place of Work.

2. TESTING AND QUALITY CONTROL

.1 Provide to the Contract Administrator, when requested and consistent with progress of the Work, test results and designs specified in the Contract Documents or required by by-laws, statutes, and regulations relating to the Work and the preservation of public health, including the following:

.1 Inspection and testing performed exclusively for the Contractor's convenience;

.2 Testing, adjusting, and balancing of process equipment and systems, conveying equipment and systems, mechanical, electrical, and instrumentation and control (I&C) equipment and systems;

.3 Mill tests and certificates of compliance;

.4 Tests for reinforcing steel unidentified by mill test reports.

.2 The Contract Administrator will select and the City will pay for the services of a testing agency or laboratory for material quality control tests that are required but not specified. Tests required by by-laws, statutes, and regulations applicable to the Work are the responsibility of the Contractor.

.3 Compliance and performance testing of equipment, pipe, conduit, wiring, and other items covered in other Divisions of this specification are the responsibility of the Contractor, unless specified otherwise. The City may replicate any series of tests to provide random checks on the compliance and performance tests at the City's cost.

.4 Remove and replace Products indicated in inspection and test reports as failing to comply with the Contract Documents.

.5 Correct improper installation procedures reported in the inspection and test reports.

.6 Pay the costs for the re-inspection and re-testing of replaced Work.

.7 It is not the responsibility of the inspection and testing agents to supervise, instruct in current methods or accept or reject a part of the Work, but only to inspect, test, and to report conditions.

.8 Notify the Contract Administrator and the appropriate inspection and testing agent not less than forty-eight (48) hours prior to the commencement of the part of the Work to be inspected and tested.

.9 Ensure the presence of the authorized inspection and testing agent at the commencement of the part of the Work specified to be inspected or tested.

.10 Ensure the inspection and testing reports are issued within forty-eight (48) hours, and that the Contract Administrator is notified forthwith if the report indicates improper conditions or procedures.

.11 Cooperate with and provide facilities for the inspection and testing agents to perform their duties.

.12 Provide proper facilities for the storage of specimens or samples at correct temperature, free from vibration or damage in accordance with the instruction of the inspection and testing agent and the governing standard.

.13 Submit four (4) copies of each laboratory test report, unless specified otherwise, each copy signed by a responsible officer of the inspection and testing laboratory. Each report is to include:

.1 Date of issue.

.2 Contract name and number.

.3 Name and address of inspection and testing company.

.4 Name and signature of inspector or tester.

.5 Date of inspection or test.

.6 Identification of the Product and Specification section covering inspected or tested Work.

.7 Location of the inspection or the location from which the tested Product was derived.

.8 Type of the inspection or test.

.9 The remarks and observations on compliance with the Contract Documents.

.14 Correct defective Work within the Contract Time; the performing of such Work is not a cause for an extension of the Contract Time.

END OF SECTION

MATERIAL AND EQUIPMENT

1. PRODUCTS

1.1 Quality of Materials

.1 Provide new materials, equipment and articles incorporated in the Work, not damaged or defective and of the best quality (compatible with specifications) for the purpose intended. If requested furnish evidence as to type, source and quality of products provided.

.2 Defective materials, equipment and articles whenever found may be rejected regardless of previous inspection. Inspection by the Contract Administrator or an inspector does not relieve the Contractor of his responsibility but is merely a precaution against oversight or error. Remove and replace defective materials at own expense and be responsible for all delays and expenses caused by rejection.

.3 Should any dispute arise as to the quality or fitness of materials, equipment or articles, the decision rests strictly with the Contract Administrator based upon the requirements of the Contract Documents.

.4 Unless otherwise indicated in the Specifications, maintain uniformity of manufacturer for any particular or like item throughout the building.

.5 Permanent labels, trademarks and nameplates on materials, equipment and articles are not acceptable in prominent locations except where required for operating instructions and when located in mechanical or electrical rooms.

1.2 Availability of Materials

.1 Immediately upon signing the Contract, review product requirements and anticipate foreseeable delivery delays in any items. If delays in deliveries of materials, equipment or articles are foreseeable, propose substitutions or other remedial action in ample time to prevent delay in performance of the Work.

.2 If such proposal is not given to the Contract Administrator, the Contract Administrator reserves the right to substitute more readily available products later in order to prevent delays at no additional cost to the City.

.3 No substitution of any item will be permitted unless the item cannot be delivered to the job site in time to comply with the Contract Work Schedule.

.4 To receive approval, proposed substitutes must equal or exceed the quality, finish and performance of those specified and/or shown, and must not exceed the space requirements allotted on the Drawings.

.5 Provide documentary proof of equality, difference in price (if any) and delivery dates in the form of certified quotations from suppliers of both specified items and proposed substitutions.

1.3 Storage, Handling and Protection of Materials

.1 Handle and store materials in a manner to prevent damage, contamination, deterioration and soiling and in accordance with manufacturer's recommendations when applicable.

.2 Store packaged or bundled products in original and undamaged condition with manufacturers' seals and labels intact. Do not remove packaging or bundling until required in the Work.

.3 Materials subject to damage from weather are to be stored in weatherproof enclosures.

.4 Store cementitious materials clear of earth or concrete floors and away from walls.

.5 When used for grout or mortar materials, keep sand clean and dry. Store on polyethylene and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet material, lumber, etc. on flat, solid supports and keep clear of ground.

.7 Store and mix paints in a room assigned for this purpose. Keep room under lock and key at all times. Remove oily rags and any other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense.

1.4 Manufacturers' Directions

.1 Unless otherwise specified, install or erect all products in accordance with manufacturers' recommendations. Do not rely on labels or enclosures provided with products. Obtain instructions directly from manufacturers.

.2 Notify the Contract Administrator, in writing, of any conflicts between the specifications and manufacturers' instructions so that the Contract Administrator may establish the course of action.

.3 Improper installation or erection of products due to failure in complying with these requirements authorizes the Contract Administrator to require any removal and re-installation that may be considered necessary, at no increase in Contract Price.

1.5 Transportation Costs of Materials

.1 Pay all costs for transportation of materials required for the Work.

2. WORKMANSHIP

2.1 General Requirements

.1 Workmanship is to be of the best quality executed by workers fully experienced and skilled in their respective trades.

.2 At all times enforce discipline and good order among workers. Do not employ any unfit person or anyone unskilled in the duties assigned to him. The Contract Administrator reserves the right to require the removal from site of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

.3 Decisions as to the quality or fitness of workmanship in cases of any dispute rests solely with the Contract Administrator whose decision is final.

2.2 Coordination

.1 Coordinate the work of all Subcontractors.

.2 Ensure that all Subcontractors examine the Drawings and Specifications for other parts of the Work which may affect the performance of their work.

.3 Ensure that sleeves, openings and miscellaneous equipment bases are provided as required for the Work.

.4 Ensure that items to be built in are supplied when required with all necessary templates, measurements and shop drawings.

2.3 Concealment

.1 In finished areas conceal all pipes, ducts and wiring except where indicated otherwise on Drawings or in Specifications.

.2 Before installation inform the Contract Administrator if there is a contradictory situation. Install as directed.

2.4 Location of Fixtures

.1 Consider the location of fixtures, outlets, and other mechanical and electrical items indicated on Drawings as approximate. The actual location of these items is to be as required or directed to site conditions at the time of installation and as is reasonable.

.2 Before installation inform the Contract Administrator if there is a contradictory situation. Install as directed.

MATERIAL AND EQUIPMENT

2.5 Cutting and Remedial Work

.1 Perform all cutting and remedial work that may be required to make the several parts of the Work come together properly. Coordinate and schedule the Work to ensure that cutting and remedial work are kept to a minimum.

.2 Employ specialists familiar with the materials affected in performing cutting and remedial work. Perform in a manner to neither damage nor endanger any portion of the Work.

.3 Do not cut, drill or sleeve any load-bearing members without written acceptance of the Contract Administrator.

.4 The Contractor is to perform work so that no dust is generated.

2.6 Fastenings

.1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent material unless otherwise specified.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive, non-staining fasteners and anchors for securing exterior work unless otherwise specified.

.4 Space anchors within their load limit or shear capacity and ensure that they provide positive permanent anchorage. Wood plugs are not acceptable.

.5 Keep exposed fastenings to a minimum, space evenly and lay out neatly.

.6 Fastenings which cause spalling or cracking of material to which anchorage is made are not acceptable.

2.7 Protection of Work In Progress

.1 Adequately protect all work completed and in progress. Repair or replace all damaged work.

.2 Prevent overloading of any part of the Work.

2.8 Cleaning

.1 Remove waste materials and debris from the site at regular intervals. Do not burn waste materials and debris on site.

3. MEASUREMENT

3.1 Metric Project

.1 Unless otherwise noted, this Project has been designed and is to be constructed in the S.I. nominal metric system of measurements.

.2 During construction, when specified metric elements are unattainable at the time they are required to meet the Contract Work Schedule, the Contractor shall notify the Contract Administrator in writing and suggest alternative substitutions. Costs due to these substitutions shall be borne by the Contractor.

END OF SECTION

EQUIPMENT INSTALLATION

1. INTENT

.1 This section describes general requirements for all equipment supplied under the Contract relating to the supervision of installation, testing, operation, and Performance Verification. The Contractor shall be responsible for the installation work, testing, operation, and Performance Verification of equipment in this Contract and for City Supplied Equipment, reference Section 01210 - City Supplied Equipment.

2. EXPERTISE AND RESPONSIBILITY

.1 The Contract Administrator recognizes the expertise of the Manufacturer.

.2 Should the Contract Administrator issue an Addendum, Field Order, Change Order, or Instruction to change the Work which would, in the opinion of the Contractor, compromise the success or safety of the Work, then it shall be incumbent on the Contractor to notify in writing the Contract Administrator to this effect within two (2) days.

3. EQUIPMENT DELIVERY

.1 The Contractor shall be responsible for equipment delivery to the Site. When the Contractor accepts the equipment delivery, he shall certify the delivery by completing *Form 100 – Certificate of Equipment Delivery*, attached to this specification.

.2 Ten (10) days before delivery, notice shall be given to the Contract Administrator so that arrangements for receipt and for inspection can be made. The shipping lists of materials will be carefully checked by the Manufacturers Representative in the presence of the Contract Administrator and the Contractor.

.3 The Contractor shall be responsible for all equipment at the Site or any alternative storage location.

.4 The Contractor shall ensure that he is fully informed of precautions to be taken in the unloading of equipment and its subsequent storage including any required maintenance.

.5 If equipment off-site storage is required, then the second move of the equipment to the Site will be at the Contractor’s cost.

4. INSTALLATION ASSISTANCE

.1 Before commencing installation of equipment, the Contractor shall arrange for the attendance of the Manufacturer's Representative to provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.

.2 The Contractor shall inform the Contract Administrator, in writing, of the attendance at the site of any Manufacturer's Representative for installation training at least fourteen (14) days prior to arrival.

.3 When the Manufacturer's Representative is satisfied that the Contractor is aware of all installation requirements, he shall so certify by completing *Form 101 – Certificate of Readiness to Install* attached to this specification.

.4 The completed form shall be delivered to the Contract Administrator prior to departure of the Manufacturer's Representative from the site.

.5 Installation of the equipment shall not commence until Contract Administrator has advised that he has received the completed Form 101.

.6 Separate copies of Form 101 shall be used for different equipment.

5. INSTALLATION

.1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Contractor shall contact the Manufacturer's Representative to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner.

.2 If it is found necessary, or if so directed by the Contract Administrator, the Contractor shall arrange for the Manufacturer's Representative to visit the site to provide assistance during installation, all at the Contractor's cost.

.3 Prior to completing installation, the Contractor shall inform the Manufacturer's Representative and arrange for the attendance at the site of the Manufacturer's Representative to verify successful installation.

.4 The Manufacturer's Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, belt tensions, rotation direction, running clearances, lubrication, workmanship and all other items as required to ensure successful operation of the equipment.

.5 The Manufacturer's Representative shall identify any outstanding deficiencies in the installation.

.6 The deficiencies shall be rectified by the Contractor and the Manufacturer's Representative will be required to re-inspect the installation, at the Contractor's cost.

.7 When the Manufacturer's Representative accepts the installation, he shall certify the installation by completing *Form 102 – Certificate of Satisfactory Installation*, attached to this specification.

.8 Deliver the completed Form 102 to the Contract Administrator prior to departure of the Manufacturer's Representative from the site.

.9 Tag the equipment with a 100 mm by 200 mm card stating "Equipment Checked. Do Not Run." stenciled in large black letters. Sign and date each card.

.10 Provide separate copies of Form 102 for different equipment.

6. OPERATION AND PERFORMANCE VERIFICATION

.1 Equipment will be subjected to a demonstration, running test, and performance test after the installation has been verified and any identified deficiencies have been remedied.

.2 During the demonstration, running tests, and performance tests, the Contractor shall operate equipment as required to complete the Performance Verification required from all Divisions of this Specification.

.3 Inform the Contract Administrator at least fourteen (14) days in advance of conducting the tests and arrange for the attendance of the Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Contract Administrator.

.4 The Manufacturer's Representative shall conduct all necessary checks to equipment and if necessary, advise the Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.

.5 The Contractor shall then operate the equipment for at least one (1) hour to demonstrate to himself the operation of the equipment and any required ancillary services. Any remedial measures required to ensure satisfactory operation shall be promptly undertaken.

.6 Demonstration:

.1 The Contractor shall then notify the Contract Administrator of his readiness to demonstrate the operation of the equipment. The Contract Administrator shall attend, as expeditiously as possible.

.2 With the assistance of the Manufacturer's Representative, the Contractor shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will be checked and if appropriate, code certifications provided.

.3 The equipment shall then be run for one (1) hour. Local controls shall be satisfactorily verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters such as temperature, pressure, voltage, vibration, etc., will be checked to ensure that they are within the specified or Manufacturer's Representative's recommended limits, whichever is more stringent.

.4 On satisfactory completion of the one (1) hour demonstration, the equipment shall be stopped and critical parameters, such as alignment, shall be rechecked.

.7 Running Test:

.1 The equipment shall be restarted and run continuously for a minimum of three (3) days (72 hours) or as specified. During this period, as practicable, conditions shall be simulated which represent maximum or most severe, average, and minimum or least severe conditions. These conditions will be mutually agreed by the Manufacturer's Representative, Contractor, the Contractor, and Contract Administrator on the basis of the information contained in the technical specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.

.8 Performance Tests:

.1 Performance tests shall be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Contract Administrator, the Manufacturer's Representative, and the Contractor.

.2 The equipment shall be run continuously for a minimum of seven (7) days (168 hours) or as specified.

.3 Performance tests shall be as dictated in the technical specifications for each item of equipment or as reasonably required by the Contract Administrator to prove adherence to the requirements listed in the specification.

.4 The Contractor shall submit the results of the performance tests within 24 hours to the Contract Administrator, and final documented and summarized results in a format acceptable to the Contract Administrator within 7 calendar days. The Contract Administrator reserves the right to request additional testing. No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the performance test(s) and receipt of the test reports.

.9 All water, chemicals, temporary power (except portable generators), heating, or any other ancillary services required to complete the initial demonstration, running test and performance tests are the responsibility of the City.

.10 Should the initial demonstration, running test or performance tests reveal any defects, then those defects shall be promptly rectified and the demonstration, running tests, and / or performance tests shall be repeated to the satisfaction of the Contract Administrator. Additional costs incurred by the Contractor, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.

.11 On successful completion of the demonstration, running test, and performance tests, *Form 103 – Certificate of Equipment Satisfactory Performance* attached to this specification will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator.

.12 The Contractor shall affix to the tested equipment a 100 mm by 200 mm card reading "Operable Condition - Do Not Operate without Contractor's Permission." stenciled on in large black letters.

EQUIPMENT INSTALLATION

CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

We certify that the equipment listed below has been received and delivered into the care of the Prime Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

EQUIPMENT INSTALLATION

CERTIFICATE OF READINESS TO INSTALL
FORM 101

I have familiarized the Contractor of the specific installation requirements related to the equipment listed below and am satisfied that he understands the required procedures.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

I certify that I have received satisfactory installation instructions from the equipment Manufacturer/ Supplier.

_____ _____
(Authorized Signing Representative of the Contractor) Date

EQUIPMENT INSTALLATION

CERTIFICATE OF SATISFACTORY INSTALLATION
FORM 102

I have completed my check and inspection of the installation listed below and confirm that it is satisfactory and that defects have been remedied to my satisfaction except any as noted below:

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

OUTSTANDING DEFECTS: _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE
FORM 103

We certify that the equipment listed below has been continuously operated for at least seven (7) consecutive days and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Contract Administrator) Date

1. Acknowledgement of Receipt of O&M Manuals.

_____ _____
(Authorized Signing Representative of the City) Date

END OF SECTION

TRAINING

1. DESCRIPTION

.1 This Section contains requirements for training the City's personnel, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance of the equipment and systems supplied and installed under this Contract. Training for City Supplied Equipment will be provided by the Supply Contractors.

.2 Two categories of training sessions are required: one set during the Commissioning Period, and one set during the Warranty Period, within six (6) months after Total Performance. The intent of the latter training session is to enable the City's personnel to ask particular questions on the operation of the specified equipment, based on their actual experience. There will be 4 different training sessions and 4 different trips.

.1 Provide 2 sessions in 2 different trips during commissioning

.2 Provide 2 sessions in 2 different trips during the warranty period

.3 Each training session will include a minimum of four (4) to eight (8) hours for each item of equipment and sub-system. Refer to the technical specifications for specific time periods for specific equipment.

.4 All training sessions will be coordinated with the Contract Administrator.

.5 Training requirements may be modified by the Contract Administrator. In this event, the Contractor will be compensated for training requirements above and beyond the training requirements of this Contract.

.6 It is the Contractors responsibility to provide Manufacturer's Representatives as specified for training purposes.

2. QUALITY ASSURANCE

.1 Training includes instruction of the City's personnel in equipment operation and preventive maintenance and instruction of mechanics, electricians, instrumentation and communications technicians in normal maintenance up to major repair.

.2 Where required by the detailed Specifications, provide on-the-job training of the City's personnel. Training sessions shall be conducted by qualified, experienced (2 years minimum), factory-trained representatives of the various equipment manufacturers. Trainers shall be capable of providing "qualified trainers" in the sessions provided as agreed upon by the Contract Administrator.

3. SUBMITTALS

.1 Submit the following information in accordance with Section 01300 - Submittals. For phased testing and start-up activities, separate submittals can be prepared for equipment

items or systems. The material will receive a "reviewed" or "reviewed as modified" status by the Contract Administrator no later than 4 weeks prior to delivery of the training:

.1 Lesson plans and training manuals, handouts, visual aids, and other reference materials for each training session to be conducted by the Manufacturer's Representatives.

.2 Date, time, and subject of each training session and identity and qualifications of individuals to be conducting the training.

.3 Training schedule. Concurrent classes will not be allowed unless approved by the Contract Administrator.

.4 The Contract Administrator requires a minimum of ten (10) business days to review training materials.

.2 Provide the following to verify the trainer's qualifications:

.1 Certification in related coursework.

.2 Three references for similar assignments where training was conducted for operation and maintenance staff.

4. LOCATION

.1 Where specified, conduct training sessions for the City's operation and maintenance personnel on the operation, care, and maintenance of the equipment and systems installed under this Contract. Training will take place at the Site or within the City of Winnipeg at an alternative site designated by the City, and under the conditions specified in the following paragraphs.

.2 Field training sessions will take place at the Site. Classroom training will take place at the Site or within the City of Winnipeg at an alternative location designated by the City. The Contract Administrator will confirm the location of classroom training.

5. LESSON PLANS

.1 Prepare formal written lesson plans for each training session and coordinate with the Contract Administrator. Lesson plans to contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan will contain a time allocation for each subject. Furnish twenty copies of final training manuals, handouts, visual aids and reference materials at least 2 weeks prior to each training session.

6. FORMAT AND CONTENT

.1 Include time in the classroom and at the location of the equipment or system for each training session. As a minimum, cover the following topics for each item of equipment or system:

.1 Familiarization

.2 Safety

.3 Operation

.4 Instrumentation and Control

.5 Troubleshooting

.6 Preventive and regular maintenance

.7 Corrective maintenance

.8 Parts

.9 Local representatives

7. DVD RECORDING

.1 DVD record each training session to provide a permanent record for the City's use. Turn CD or DVDs over to the Contract Administrator after the training is completed. Advise all Manufacturers providing training sessions that the training material will be video recorded.

8. TRAINING

8.1 General Requirements

.1 Conduct training in conjunction with the Commissioning Period. Schedule classes such that classroom sessions are interspersed with field instruction in logical sequence. Arrange to have the training conducted on consecutive days, with no more than 6 hours of classes scheduled for any one day.

.2 Provide acceptable operation and maintenance manuals prior to Form 103 Substantial Performance.

.3 Contractor shall be responsible for any Audio-Visual aids required for training sessions.

8.2 Operator Classroom Training

.1 As a minimum, classroom equipment training for operations personnel shall include:

.1 The equipment's specific location in the WTP and an operational overview. Use slides, computer presentations, and drawings to aid discussion.

.2 Purpose and WTP function of the equipment.

.3 The operating theory of the equipment.

.4 Start-up, shutdown, normal operation, and emergency operating procedures, including system integration and electrical interlocks, if any.

.5 Safety items and procedures.

.6 Routine preventive maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

.7 Operator detection, without test instruments, of specific equipment trouble symptoms.

.8 Required equipment exercise procedures and intervals.

.9 Routine disassembly and assembly of equipment if applicable for purposes such as operator inspection of equipment.

8.3 Operator Hands-On Training

.1 As a minimum, hands-on equipment training for operations personnel shall include:

.1 Identifying instrumentation: Location of primary element; location of instrument readout; discuss purpose, basic operation, and information interpretation.

.2 Discussing, demonstrating, and performing standard operating procedures and round checks.

.3 Discussing and performing the preventive maintenance activities.

.4 Discussing and performing start-up and shutdown procedures.

.5 Performing the required equipment exercise procedures.

.6 Performing routine disassembly and assembly of equipment if applicable.

.7 Identifying and reviewing safety items and performing safety procedures, if feasible.

.8 Safety procedures.

8.4 Maintenance Classroom Training

.1 Classroom equipment training for the maintenance and repair personnel shall include:

.1 Basic theory of operation.

.2 Description and function of equipment.

.3 Routine start-up and shutdown procedures.

.4 Lockout procedures and the location of lockouts.

.5 Normal and major repair procedures.

.6 Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

.7 Routine and long-term calibration procedures.

.8 Safety procedures.

.9 Preventive maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

8.5 Maintenance Hands-On Training

.1 Hands-on equipment training for maintenance and repair personnel shall include:

.1 Locating and identifying equipment components.

.2 Reviewing the equipment function and theory of operation.

.3 Reviewing normal repair procedures.

.4 Performing routine start-up and shutdown procedures.

.5 Reviewing and performing the safety procedures.

.6 Performing City-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

.7 Reviewing and using equipment manufacturer's manuals in the hands-on training.

8.6 Equipment and Systems for Training

.1 As a minimum, provide training during the Commissioning Period for all equipment and sub-systems listed in all Divisions in the technical specifications and shown on the contract drawings.

.2 City Supplied Equipment training during Commissioning Period will be provided by the Supply Contractors.

.3 Provide training for the equipment during the Warranty Period six (6) months after Total Performance.

.4 Coordinate and finalize with the Contract Administrator on training schedules and duration of each training session.

8.7 Training Completion Forms

.1 Form T1: To be completed for initial training. One (1) form is to be used for each equipment/ system for which training has been provided.

TRAINING

CERTIFICATE OF SATISFACTORY TRAINING
FORM T1

We certify that the initial training for the equipment listed below has been provided as per the Specifications.

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Trainer) Date

_____ _____
(Contractor) Date

_____ _____
(Authorized Signing Representative of the City) Date

END OF SECTION

COMMISSIONING

1. GENERAL

.1 Due to the sequential tendering and construction approach for the Winnipeg WTP, the Commissioning of the WTP will be divided into several phases to improve Commissioning efficiency and reduce overall System Demonstration time. Before System Demonstration can begin, all dependant processes must have been checked out and to be determined in conformance with the Specifications. All equipment manufactures must have verified the correct installation of their respective equipment and they must have performed running tests and performance tests as specified.

.2 This Section describes the commissioning plan and the Contractor's responsibilities in the Commissioning of the process, mechanical, electrical, and other systems to be installed as part of this Contract.

.3 Equipment furnished under this Contract and the City Supplied Equipment will be Commissioned by the Contract Administrator and the Commissioning Team with assistance from the Contractor and Supply Contractors. The Contractor shall provide the services of a qualified representative to assist in the System Demonstration and performance verification of all of the equipment installed under this contract. System Demonstration and training activities cannot begin until Forms 102 and 103 have been completed for all equipment installed under this contract.

.4 The Contractor shall refer to Sections 01210, 01300, 01650, 01664, and Divisions 13, 15, 16, and 17 for details on the System Demonstration procedures not included in this section.

.5 System Demonstration of the main WTP is expected to begin in 2008. The WTP Start-up and System Demonstration procedures will also be linked to Start-up and System Demonstration of ancillary facilities such as the Chemical Storage / Chemical Feed Building and the On-site Hypochlorite Generation Building.

.6 The WTP can be divided into two treatment trains. Each train will have its own independent System Demonstration period and cannot be tested concurrently during this time. Once both trains have completed System Demonstration, both trains will be brought on line and tested at the same time to mimic normal operation of the WTP. While the WTP is producing or recycling water with or without chemical, the quality of the finished water will be closely monitored to try and minimize flow interruption of potable water to the City. Water production, disposal, or recycling criteria and procedures will be developed by the Commissioning Team.

.7 The Contractor shall note that for materials and equipment installed in this Contract, warranty will not begin until issuance of Total Performance.

2. DEFINITIONS

.1 System: For the purpose of this Section, a system shall be defined as the equipment, piping, controls, ancillary devices, electrical power, etc. which together perform a specific function at the facility.

.2 Sub System: For the purpose of this Section, a Sub System is defined as a smaller grouping of equipment, piping, controls, ancillary power, electrical devices, etc which performs an even more specific function than a System.

.3 Commissioning: The process of ensuring that systems and sub-systems are installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent over the long-term. Commissioning is a process that is not limited to the start-up period.

.4 Start-up: All inspection, preparation, testing, adjustment calibration and tuning required to put devices and systems into operating condition. Start-up includes; Demonstration, Running Tests, and Performance Tests.

.5 Demonstration: During Start-up, comprises of running equipment for one (1) hour to demonstrate that equipment is properly installed.

.6 Running Test: During Start-up, comprises of running equipment continuously for a minimum of three (3) days (72 hours) or as specified. During this period, as practicable, maximum, average, and minimum conditions will be simulated.

.7 Performance Test: During Start-up, comprises of equipment running continuously for a minimum period of seven (7) days (168 hours) or as specified. The Performance Test can be conducted either concurrent or subsequent to the Running Test as advised by the Contract Administration. On successful completion of Demonstration, Running Tests, and Performance Tests, Form 103 – Certificate of Equipment Satisfactory Performance shall be completed.

.8 System Demonstration: For the purpose of this specification section, shall be defined as the successful operation of process treatment trains in accordance with its design requirements for a total period of forty-two (42) days, the last seven (7) of which shall be consecutive, unless otherwise specified. On successful completion of System Demonstration, Form 104 – Certificate of Satisfactory Process Performance will be completed.

.9 Commissioning Operations Agent: A qualified maintenance/operations team retained by the City under a separate contract that takes primary responsibility for operation of the WTP during the Commissioning Period or longer as specified by their contract.

.10 Commissioning Period: Period between Start-up and Total Performance during which a system is operated under Commissioning Operations Agent's control to demonstrate to the City it that it operates in conformance with the design intent.

.11 Commissioning Team: Team led by the Contract Administrator which is made up of members from the City, Commissioning Operations Agent, and Contract Administrator. The Commissioning Team will coordinate System Demonstration activities through the Contract Administrator and develop an overall commissioning plan and schedule.

3. SEQUENCE

.1 The general sequence of events is summarized by the following table. Due to the phased nature of construction, this sequence of events will be further developed by the Contract Administrator to suit specific equipment, system, sub systems, processes, and critical events.

SEQUENCE ITEM	DESCRIPTION
A. Equipment Delivery	1) Contract Administrator, Contractor, Supply Contractor inspect equipment delivery 2) Contractor accepts equipment delivery 3) Contractor Sign-off Form 100 – Certificate of Equipment Delivery 4) Equipment stored on Site or City Warehouse
B. Complete Installation and Demonstration and Running Tests	1) Supply Contractor or Manufacturers Representatives to provide installation instructions/training to Contractor 2) Supply Contractor or Manufacturers Representatives to Complete Form 101 – Certificate of Readiness to Install 3) Contractor to complete installation 4) Supply Contractor or Manufacturers Representatives inspect installation 5) Supply Contractor or Manufacturers Representatives to complete Form 102- Certificate of Satisfactory Installation 6) Begin Start-up Process 7) Complete One (1) hour Demonstration 8) Complete minimum three (3) day Running Test 9) Complete process related deficiency list items 10) Tag all components ready for Performance Testing
C. Performance Testing and Completion of Start-up	1) Contractor to inform Contract Administrator 14 days in advance of Performance Testing 2) Confirm required staff is available 3) Review safety procedures as required with Contract Administrator 4) Review operational requirements (output & performance) with Contract Administrator 5) Supply Contractor or Manufacturers Representatives to conduct all necessary checks prior to confirming equipment ready to run 6) Commence Performance Testing period – minimum seven (7) days 7) Sign-off Form 103 – Certificate of Equipment Satisfactory Performance 8) Within 14 days of Substantial Performance, provide final O&M manuals
D. System Demonstration	1) After Form 103 completed, Commissioning Operations Agent to operate and maintain plant 2) Review safety procedures as required with Contract Administrator 3) Review operational requirements (output & performance) with Contract Administrator 4) Commence System Demonstration Testing

E. **Training**	1) After completion of Form 103 and prior to completion of Form T1, Contractor to include Manufacturers Representative training as part of Contract Bid 2) Supply Contractors include training as part of their contracts 3) After all training included in Contract complete, sign-off Form T1 – Certificate of Satisfactory Training 3) After completion of Form T1, Contractor to provide additional training on as-required time and material basis
F. **Total Performance**	1) Completion of Form T1 and successful Performance Testing 2) Final completion and cleanup 3) Complete Form 104 – Certificate of Satisfactory Process Performance 4) Certificate of Total Performance complete 5) Provide warranty services as provided under the Contract

.2 Final Operation and Maintenance Manuals shall be available as per the requirements of Section 01730 at least fourteen (14) days prior to the start of System Demonstration and prior to the completion of Form 103.

.3 The Contract Administrator will make Operating Descriptions available prior to System Demonstration.

.4 During Start-up, start and run systems in manual mode. Turn separate items of equipment to automatic in a planned and logical manner as directed by the Contract Administrator. Ensure that the control system is operating the equipment in a manner which precludes damage of the equipment and which is consistent with the process operating requirements.

.5 System Demonstration Testing Period of forty two (42) days. The equipment shall operate continuously and successfully through the last seven (7) days of the Sysytem Demonstration Period as approved by the Contract Administrator.

4. COMMISSIONING ROLES AND RESPONSIBILITIES

.1 Contractor

.1 Coordinate with and report directly to the Contract Administrator

.2 Meet with the Supply Contractors and Manufacturers Representatives and be trained on the installation of all equipment. Sign-off Form 101: Certificate of Readiness to Install.

.3 Maintenance of equipment and subsystems.

.4 Liaise with the Supply Contractors and Manufacturers Representatives as required during installation to ensure proper equipment installation and sign-off Form 102: Certificate of Satisfactory Installation.

.5 Correct all installation deficiencies as required by the Supply Contractors and Manufacturers Representatives.

.6 Red tag, lockout and maintain control of all power supplies, valves, etc.

.7 Attend Commissioning related meetings in Winnipeg.

.8 As directed by the Contract Administrator, provide personnel representing the appropriate trades and equipment Manufacturers during training and Commissioning Period as per the Contract Work Schedule and Specifications.

.9 Operate all equipment under the direction of the Supply Contractors and Manufacturers Representatives as required to demonstrate satisfactory performance. Issue Form 103: Certificate of Satisfactory Performance

.10 After completion of Form 103, green tag, and turn over control of all power supplies, valves, etc., to the Commissioning Operations Agent.

.11 List of all personnel who the Contractor plans for System Demonstration and hand-over with information indicating their qualifications for this work.

.12 Operate all equipment installed under this contract, and with the assistance of the Supply Contractors and Manufacturers Representatives as required, to complete Performance Verification.

.13 Provide the Contract Administrator with red-lined drawings for record drawing preparation.

.2 Manufacturer's Representatives

.1 Provide installation training to the Contractor and issue Form 101: Certificate of Readiness to Install.

.2 Provide inspection of the installation of equipment supplied by them and issue form 102: Certificate of Satisfactory Installation.

.3 Attend Commissioning scoping meetings in Winnipeg.

.4 Provide Shop Drawings and O&M Manuals.

.5 Review Commissioning Team's test procedures to ensure safety and feasibility.

.6 Direct the Contractor and execute Performance Tests witnessed by the Contract Administrator and issue Form 103: Certificate of Satisfactory Performance.

.7 Assist the Contractor during the Commissioning Period and train the City's operating personnel.

.8 For the City Supplied Equipment, the Supply Contractors will provide similar services as outlined above.

5. COMMISSIONING PLAN

.1 The Commissioning Team will develop a detailed methodology for the System Demonstration of each system at least ninety (90) Calendar Days prior to planned start of System Demonstration. The plan will include the following:

.1 Detailed schedule of events, including but not limited to the schedule for completion of testing of all component parts of the system in accordance with Section 01210 and Section 01650 prior to System Demonstration.

.2 Methods and criteria for water management; sending water to the City, recycling or disposing of partially treated water, emergency overflows, and disposing of any sludge or other residual solids generated during the Commissioning Period and during Performance Verification.

.3 Sampling and analytical program for tests necessary to verify compliance with specified performance criteria.

.4 Training requirements and planned attendance schedule for Manufacturer's Representatives.

.5 Workplace Health and Safety Plan.

.6 Chemical handling procedures and responsibilities.

.7 Contingency plans in the event of a process malfunction.

.8 Drawings and sketches as required to illustrate the planned sequence of events.

.9 List and details for all temporary equipment (pumps, etc.) required to facilitate System Demonstration.

6. PREPARATION FOR START-UP AND SYSTEM DEMONSTRATION

.1 All process, mechanical, electrical, control and miscellaneous equipment related to a System shall be successfully installed and tested by the Contractor in accordance with Section 01210 and Section 01650 and any specific requirements noted in other Divisions. Form 103 shall be completed for each item.

.2 Piping, wiring, and other conduit systems shall be finished and tested. Form 103 shall be completed.

.3 Electrical connections shall be completed, inspected, and tested per the requirements of Division 16.

.4 Control systems shall be completed and the related control software debugged, as per Divisions 11, 15, and 17.

.5 Temporary equipment shall be installed and tested as necessary to ensure that it functions reliably and consistently through the Commissioning Period.

.6 Prior to completing Form 103, all applicable regulatory inspections shall be completed to the satisfaction of the governing authorities.

7. CONTROLS

.1 All controls installed by the Contractor shall be tested prior to System Demonstration.

.2 The Contract Administrator will arrange for the simulation of the control sequences or will allow for the operation of the system without the features included in the work of others. Every effort shall be made to ensure that the Commissioning Period provides for the full and comprehensive operation of the equipment under all anticipated normal and adverse operating conditions.

8. WTP UTILITY SERVICES

.1 Utility services will be provided by the City as specified in Section 01210 and Section 01650. Provision of these services will be limited to reasonable levels as determined by the Contract Administrator.

9. MANPOWER

.1 Supply all competent staff required during the Commissioning Period as requested by the Contract Administrator to assist the Commissioning Team, Operations Agent, and City's staff in the operation of the WTP.

.2 Supply competent staff capable of maintaining, repairing and adjusting the equipment and controls to achieve the intended design functions during the Commissioning Period.

.3 Ensure equipment Manufacturer's Representatives are available as necessary to certify adjustments in equipment, to guide in setting correct operating limits, to provide training, and to generally provide input as required for the appropriate operation of the equipment.

10. OPERATING DESCRIPTIONS

.1 Operating descriptions have been prepared for the WTP systems. To some degree, the intent of these have been included in the Drawings and technical Specifications. Information outlining the operating requirements is available from the Contract Administrator.

11. COMMISSIONING PERIOD

.1 All components and systems will be operated in the automatic/manual and the remote/local modes as required to prove proper operation.

.2 Samples of process flows, when necessary to prove performance, will be obtained and analyzed on a regular basis by others.

12. ACCEPTANCE

.1 System Demonstration shall be considered acceptable when the process has operated in a stable manner, satisfying the design criteria for a period of forty two (42) days, the last seven (7) of which shall be continuous and consecutive, unless otherwise specified.

.2 When the Contractor achieves Substantial Performance, the process Systems will be formally accepted for operation and routine maintenance by the Commissioning Operations Agent. On successful completion of System Demonstration and Training, Form 104: Certificate of Satisfactory Process Performance, attached to this specification will be signed by the representative of the Manufacturer, Contractor, Contract Administrator, and City.

.3 An acceptance meeting must be held at the end of the System Demonstration test to confirm the status of each system. Contractor shall attend the acceptance meeting.

CERTIFICATE OF SATISFACTORY PROCESS PERFORMANCE
FORM 104

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Performance Testing Criteria. The equipment is therefore classed as "conforming".

PROJECT: _____

SYSTEM DESCRIPTION: _____

_____

TAG NO (S): _____

REFERENCE SPECIFICATION (S): _____

(Authorized Signing Representative of the Manufacturer)	Date
(Authorized Signing Representative of the Contractor)	Date
(Authorized Signing Representative of the Contract Administrator)	Date
(Authorized Signing Representative of the Commissioning Operations Agent)	Date
(Authorized Signing Representative of the City of Winnipeg)	Date

END OF SECTION

OPERATION AND MAINTENANCE MANUALS

1. DESCRIPTION

.1 This Section supplements the requirements for the provision of Operation and Maintenance (O&M) Manuals as described in Section 01300.

.2 Furnish complete operations manuals and maintenance information as specified in this Section for installation, check-out, operation, maintenance, and lubrication requirements for each unit of mechanical, electrical, and instrumentation equipment or system and each instrument.

.3 Customize the operations manuals and maintenance information to describe the equipment actually furnished. Do not include extraneous data for models, options, or sizes not furnished (cross out or remove if required). When more than one model or size of equipment type is furnished, show the information pertaining to each model, option, or size.

.4 Assemble, coordinate, bind, and index required data into an O&M Manual.

.5 Three (3) draft copies of the manuals shall be submitted a minimum of sixty (60) days prior to Substantial Performance of the Work for review and comments. A maximum of eight (8) weeks after review, twelve (12) copies of the final manuals shall be supplied.

.6 In addition to the twelve (12) hard copies, submit an electronic version of the O&M Manual.

.7 Materials: Label each Section with tabs protected with celluloid covers, fastened to hard paper dividing sheets.

.8 Type lists and notes.

.9 Drawings, diagrams and Manufacturer's literature must be legible. Drawings larger than 280 x 430 mm must be folded and placed inside plastic pockets.

2. OPERATION AND MAINTENANCE MANUAL CONTENTS AND ORGANIZATION

.1 Provide the Manufacturer’s standard O&M manuals for the equipment or instruments supplied. If the Manufacturer's standard manuals do not contain all the required information, provide the missing information in supplementary documents and Drawings inserted behind appropriate tabs in the manual binder.

.2 When more than one (1) piece of identical equipment or instruments are supplied, provide only one (1) set of operations manuals.

.3 One (1) set of operations manuals may be provided when more than one (1) piece of similar equipment or instruments are supplied, such as different sizes of the same model, and all similar pieces are covered in the same standard Manufacturer's O&M manual.

.4 When similar equipment or instruments are provided by the same Manufacturer, but are not covered in the same standard Manufacturer's O&M manual, their specific manuals may be

bound in the same three (3)-ring binder. Separate specific manuals with tab dividers labelled with the appropriate equipment numbers.

.5 Provide a cover sheet, bound as the first page of each manual, with the following information:

.1 Contract name and number.

.2 Equipment number or, if more than one (1) piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.

.6 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.

.7 Insert the specific information described below in the O&M manuals in a format similar to that listed:

.1 Tab 1 – General Information

.1 Functional title of the system, equipment, material, or instrument.

.2 Relevant Specification Section number and Drawing reference.

.3 Address and telephone number of the Manufacturer and the nearest Manufacturer's Representative.

.2 Tab 2 - Equipment Data

.1 Insert Specification Section and completed Equipment and Instrumentation Data sheets for equipment supplied. Attach all Addenda, Change Orders, and change directives that refer to that specific item of equipment.

.3 Tab 3 – Operation Information

.1 Include the Manufacturer's recommended step-by-step procedures for starting and stopping under normal and emergency operation. Include all specified modes of operation including recommended operation after the assembly or equipment has been in long-term storage.

.2 Provide control diagrams with data and information to explain operation and control of systems and specific equipment. Identify normal operating setpoints and alarm conditions.

.3 Provide technical information on all alarms and monitoring devices provided with the equipment.

.4 Provide troubleshooting information. Clearly identify which problems to look for and how to solve them.

OPERATION AND MAINTENANCE MANUALS

.4 Tab 4 - Technical Data

.1 Insert Manufacturer's Technical Specification and data sheets.

.2 Insert Manufacturer's certified performance and calibration curves for the equipment and instruments.

.5 Tab 5 - Maintenance Information

.1 Include the description and schedule for all Manufacturers' recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate whether procedure is to be done daily, weekly, monthly, quarterly, semi-annually, annually, or fill in hours of operation.

.6 Tab 6 - Maintenance Instructions

.1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing, and calibrations. Include protective device settings, warnings, and cautions to prevent equipment damage and to insure personnel safety.

.2 Provide Manufacturer's description of routine preventive maintenance, inspections, tests, and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.

.3 Provide Manufacturer's recommendations on procedures and instructions for correcting problems and making repairs.

.4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.

.5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings, and adjustments required.

.7 Tab 7 - Assembly Drawings

.1 Provide Drawings which completely document the equipment, assembly, subassembly, or material for which the instruction is written. Provide the following Drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, Shop Drawings, installation Drawings, layout and dimension Drawings, and electrical component fabrication Drawings.

.2 Provide clear and legible illustrations, Drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies.

.8 Tab 8 - Bills of Materials

.1 Provide a clear, legible copy of the Bill of Materials that was shipped with the equipment. The Bill of Materials should list all equipment, instruments, components, accessories, tools, and other items that were shipped with the equipment.

.9 Tab 9 - Lubrication Data

.1 Provide a table showing recommended lubricants for specific temperature ranges and applications.

.2 Provide charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, and capacities.

.3 If the equipment or instrument is not lubricated, add a sheet under this Tab with the words "Not Applicable".

3. FIELD CHANGES

.1 Following the acceptable installation and operation of an equipment item, modify and supplement the item's instructions and procedures to reflect any field changes or information requiring field data.

4. COMMISSIONING DATA

.1 Provide in hard cover three (3)-ring binders for 215 x 280 mm paper labelled "Commissioning Data" one copy of:

.1 All completed equipment testing and commissioning forms.

.2 All completed equipment checklists and performance reports, including noise and vibration analysis, instrumentation calibration data, and all other relevant information.

.3 All system performance reports.

5. WARRANTIES

.1 Provide in hard cover three (3)-ring binders for 215 x 280 mm paper labelled "Warranties" one (1) copy of:

.1 Manufacturers' standard Warrants and Guarantees. Include the name and telephone number of the contact person. Indicate the time frame of each Warrant or Guarantee on the list.

END OF SECTION

WEIR PLATES

1. GENERAL

1.1 Work Included

.1 This section includes all metal work for process engineered weirs and baffle plates in stainless steel as shown on the process Drawings.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CAN/CSA G40.21, Structural Quality Steels.

.2 ASTM A325, Specifications for High Strength Steel Bolts Classes 10.9 and 10.9.3 for Structural Steel Joints.

.3 CSA W59, Welded Steel Construction.

1.3 Submittals for Review

.1 Submit Shop Drawings in accordance with Section 01300 – Submittals.

.2 Indicate materials, core thicknesses, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.

.3 Drawings to bear the stamp and signature of a Professional Engineer registered in the Province of Manitoba for all fabricator designed assemblies, components and connections.

2. PRODUCTS

2.1 Materials

.1 Stainless steel plate: to AISI Type 316L, as shown.

.2 Welding materials: to CSA W59, or CSA W59.2.

.3 Bolts: stainless steel to AISI Type 316, as shown.

.4 Anchor bolts: Stainless Steel.

2.2 Weir Plates

.1 Refer to standard details on process Drawings.

.2 316L stainless steel shall be a minimum thickness of 5 mm.

.3 Fabricate weir plates with slotted holes or provide with adjustable mounting clamps, each allowing for them to be firmly affixed to the supporting structure. Make overflow weirs vertically adjustable at least 150 mm. Make underflow weirs vertically adjustable at least 150 mm.

.4 Make the top edge of overflow weirs and the bottom edge of underflow weirs straight and true.

.5 Where necessary to prevent leakage around the weir plate, provide neoprene gaskets to seal between the weir and the structure.

.6 Provide all mounting angles, supports, etc. as required to install the weirs.

2.3 Fabrication

.1 General

.1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

.2 Where possible, fit and shop assemble work, ready for erection.

.2 Stainless Steel Welding

.1 Conform to stainless steel welding procedures tested and qualified in accordance with ASME IX, which have been sealed, signed and dated by a Professional Engineer registered in the Province of Manitoba.

.2 Welders and welding operators shall be qualified in accordance with either AWS D1.1, CSA W47.1 or ASME IX.

.3 Grind or buff all welds to a minimum radius of 6 mm on all edges and corners to achieve a smooth surface, eliminate any pockets and eliminate any protruding root passes. Adhere to latest edition of NACE RP0178. If material thickness will not allow 6 mm radius, make radius one half of material thickness

.4 Ensure the weld cap is free of excessive weld material and free of discoloration due to welding

.5 Passivation

.1 Comply with ASTM A380, Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems, and ASTM A967, Standard Specification for Chemical Passivation Treatment for Stainless Steel Parts, latest edition.

.2 Use fine grit carbide sandpaper to remove any discoloration, such as bluish due to overheating.

.6 The Manufacturer shall maintain a welding record which identifies all welds related to the welder or the welding operator.

.7 The chemical analysis of the material used, as supplied by the stainless steel Manufacturer, shall be available to the Contract Administrator upon request.

.8 Grinding wheels shall be correctly selected for use on stainless steel and grinders shall be identified by a distinguishable colour to prevent accidental contamination.

.9 All metal that is to be fused during welding shall be clean of lubricants, grease, paint, fillings, and cuttings. Cleaning may be done only with alcohol or acetone. Chlorinated solvents shall not be used for cleaning purposes.

.10 Joint alignment shall be done with mechanical devices and shall be free of depressions and bumps. Under no circumstances shall heat be used in the alignment of joints.

.11 Tack welds shall be made of the same quality as the final weld. It shall be made small enough to allow them to be absorbed into the following beads, and they shall have oxides removed in advance of making the finishing weld.

.12 All scale, oxides, and discoloration shall be removed from the welds.

.13 Provide electrodes compatible with the material welded and which deposit metal with strength and corrosion resistance properties at least equivalent to the base metal.

.3 Welding Testing and Inspection

.1 Welders

.1 As a minimum, welders will hold a Journeyman Welder's Certificate or shall have qualifications and certifications in accordance with AWS D1.1, CSA W47.1 or ASME IX.

.2 Welder shall be qualified for the processes and filler metals they are using.

.2 Weld Tests

.1 Stainless Steel Welds

.1 All stainless steel welds shall be 100% visually inspected by a registered inspector and any imperfections shall be made good as required by the applicable Code and to the satisfaction of the Contract Administrator.

.2 Stainless steel welds shall have no discoloration. Any discoloration, such as bluish tint at welds, will require spot pickling and passivation using paste containing nitric acid and hydrofluoric acid, followed by rinsing and drying as indicated previously.

.2 In case of dispute one or more rejected welds will be cut out to verify by visual examination. Costs for additional testing will be borne by the Contractor if the weld(s) are defective and by the City if the weld(s) are not defective.

.3 All repairs of defective welds will be at the Contractor's expense.

.3 Hold Point

.1 After all weld fabrication and clean-up, the welded components shall be inspected and tested.

3. EXECUTION

3.1 Preparation

.1 Prevent electrolytic action between dissimilar metals and materials, unless they are galvanized or stainless steel.

.2 Where dissimilar metals are mated, isolate all mating surfaces and bolts, nuts and washers to prevent galvanic corrosion.

.1 Clean and coat surfaces that are to be assembled or bolted together for shipment.

.2 Provide match markings on sections for ease of field erection.

.3 Ensure ease of field erection by test assembly in the shop where field assembly may be awkward or difficult.

3.2 Erection

.1 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.2 Provide suitable means of anchorage acceptable to Contract Administrator such as dowels, anchor clips, bar anchors, expansion and adhesive, bolts and shields, and toggles.

.3 Make field connections with stainless steel bolts Type 316. Do not field weld.

END OF SECTION

COATING SYSTEMS FOR STEEL TANKS AND PIPES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 NSF International (NSF): 61, Drinking Water System Components-Health Effects.

.2 Steel Structures Painting Council (SSPC):

.1 SP 1, Surface Preparation Specification No. 1, Solvent Cleaning.

.2 SP 2, Hand Tool Cleaning.

.3 SP 3, Power Tool Cleaning.

.4 SP 5, White Metal Blast Cleaning.

.5 SP 6, Commercial Blast Cleaning.

.6 SP 7, Brush-Off Blast Cleaning.

.7 SP 8, Pickling.

.8 SP 10, Near-White Blast Cleaning.

.9 SP 11, Power Tool Cleaning to Bare Metal.

.10 SP 12, High Pressure Water Jetting.

.3 American Water Workers Association:

.1 C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

.4 National Association of Corrosion Engineers (NACE):

.1 RP0188-99 Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates

1.2 Definitions

.1 Terms used in this Section:

.1 Coverage: Total minimum dry film thickness in mil, or m^2/L.

.2 MDFT: Minimum Dry Film Thickness, mm.

.3 MDFTPC: Minimum Dry Film Thickness per Coat, mm.

.4 Mil: Thousandth of an inch.

.5 PSDS: Paint System Data Sheet.

.6 SP: Surface preparation.

1.3 Submittals

.1 Action Submittals:

.1 Data Sheets:

.1 For each paint system used, furnish a painting system data sheet, and paint colours available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers.

.2 Submit required information on a system-by-system basis.

.3 Provide copies of paint system submittals to coating applicator.

.4 Indiscriminate submittal of Manufacturer's literature only is not acceptable.

.2 Detailed chemical and gradation analysis for each proposed abrasive material.

.3 Samples: Proposed Abrasive Materials: 2 kg minimum Sample for each proposed.

.2 Informational Submittals:

.1 Anticipated tank coating sequence.

.2 Coating Manufacturer's letter or certificate stating that the proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.

.3 Copy of applicable NSF listings.

.4 Applicator's Qualification: List of references substantiating experience.

.5 Manufacturer's written instructions for applying each type of coating.

.6 Field Testing: Inspection and test reports.

.7 Certificate of Satisfactory Installation, Form 102.

1.4 Quality Assurance

.1 Applicator Qualifications: Minimum five (5) years' experience in application of specified products.

.2 Regulatory Requirements:

.1 Meet federal, provincial, and local requirements limiting the emission of volatile organic compounds.

.2 Perform surface preparation and painting in accordance with recommendations of the following:

.1 Paint Manufacturer's instructions.

.2 SSPC-PA Guide No. 3, Guide to Safety in Paint Applications.

.3 Federal, provincial, and local agencies having jurisdiction.

.3 Mockup:

.1 Before proceeding with Work under this Section, finish one complete space or item of each colour scheme required showing selected colours, finish texture, materials, quality of Work, and special details.

.2 After approval, sample spaces or items shall serve as a standard for similar work throughout the Work.

1.5 Delivery, Storage, and Handling

.1 Deliver materials to Site in unopened containers labeled with designated name, date of manufacture, colour, and Manufacturer.

.2 Store paints in a protected area that is heated or cooled as required to maintain temperatures within the range recommended by paint Manufacturer.

.3 Shipping:

.1 Protect precoated items from damage. Batten coated items to prevent abrasion.

.2 Use nonmetallic or padded slings and straps in handling.

1.6 Environmental Requirements

.1 Do not apply paint in temperatures outside of Manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.

.2 Do not perform abrasive blast cleaning whenever relative humidity exceeds 85%, or whenever surface temperature is less than 3°C above dewpoint of ambient air.

2. PRODUCTS

2.1 Manufacturers

.1 Ameron Protective Coatings, Brea, CA.

.2 Benjamin Moore Paints, New York, NY.

.3 Carboline Coatings Company, St. Louis, MO.

.4 ICI Devoe, Louisville, KY.

.5 DuPont Chemical Co., Wilmington, DE.

.6 Hempel/Reliance Paints, Houston, TX.

.7 Keeler and Long, Inc., Watertown, CT.

.8 Master Builders, Inc., Cleveland, OH.

.9 Plas-Chem Coatings, St. Louis, MO.

.10 International Protective Coatings, Houston, TX.

.11 Sherwin-Williams, Cleveland, OH.

.12 Tnemec Coatings, Kansas City, MO.

.13 Plasite Protective Coatings, Green Bay, WI.

.14 Cloverdale Paint, Surrey, BC.

.15 Enviroline, Pompano Beach, FL.

2.2 Materials

.1 Quality: Manufacturer's highest quality products and suitable for intended use.

.2 Abrasives: As recommended by paint Manufacturer to produce surface profile recommended for specific paint system.

.3 Materials Including Primer and Finish Coats: Produced by same paint Manufacturer.

.4 Thinners, Cleaners, Driers, and Other Additives: As recommended by paint Manufacturer of the particular coating.

.5 Polyamide Epoxy: Polyamide epoxy coatings approved for potable water contact conforming to NSF 61.

.6 Polyurethane Enamel: Two-component, aliphatic or acrylic based polyurethane; high gloss finish.

.7 Wash Primer: Vinyl butyral acid.

.8 Rust Inhibitive Primer: Single package steel primer with anticorrosive pigment loading.

.9 Alkyd Enamel: Gloss finish, medium oil length.

2.3 Colours

.1 Formulate with colorants free of lead and lead compounds.

.2 Furnish as selected by Contract Administrator.

.3 Proprietary identification of colours is for identification only; selected manufacturer may supply matches.

2.4 Mixing

.1 Multiple-Component Coatings:

.1 Prepare using all the contents of the container for each component as packaged by paint Manufacturer.

.2 No partial batches will be permitted.

.3 Do not use multiple-component coatings that have been mixed beyond their pot life.

.4 Furnish small quantity kits for touchup painting and for painting other small areas.

.5 Mix only components specified and furnished by paint Manufacturer.

.6 Do not intermix additional components for reasons of colour or otherwise, even within the same generic type of coating.

.2 Keep paint material containers sealed when not in use.

3. EXECUTION

3.1 General

.1 Coatings and linings on steel piping shall be applied in strict accordance with AWWA C210.

3.2 Preparation

.1 Notify the Contract Administrator at least seven (7) days prior to start of shop blast cleaning to allow for inspection of the Work during surface preparation and shop application of paints. Work shall be subject to the Contract Administrator approval before shipment to Site.

.2 Items such as structural steel, metal floor doors, manways, and frames, metal louvers, and similar fabricated items may be shop prepared and primed. Centrifugal wheel blast cleaning is an acceptable alternative to shop blast cleaning.

.3 Remove, mask, or otherwise protect hardware, machined surfaces, nameplates on machinery, and other surfaces not intended to be painted.

.4 Protect all surfaces adjacent to, or downwind of Work area from overspray. Contractor shall be responsible for any damage resulting from overspray.

3.3 Preparation of Surfaces

.1 Metal Surfaces:

.1 Meet requirements of the following SSPC Specifications as referenced in specific coating systems:

.1 Solvent Cleaning: SP 1.

.2 Hand Tool Cleaning: SP 2.

.3 Power Tool Cleaning: SP 3.

.4 White Metal Blast Cleaning: SP 5.

.5 Commercial Blast Cleaning: SP6

.6 Brush-Off Blast Cleaning: SP 7.

.7 Near-White Blast Cleaning: SP 10.

.8 Power Tool Cleaning to Bare Metal: SP 11.

.9 High Pressure Water Jetting: SP 12.

.2 Wherever the words "solvent cleaning", "hand tool cleaning", "wire brushing", or "blast cleaning", or similar words of equal intent are used in these Specifications or in paint Manufacturer's specifications, they shall be understood to refer to the applicable SSPC Specifications listed above.

.3 Hand tool clean areas that cannot be cleaned by power tool cleaning.

.4 Preblast Cleaning Requirements:

.1 Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

.2 Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.

.3 Clean small isolated areas as above or solvent clean with suitable solvents and clean cloths.

.4 Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

.5 Welds and Adjacent Areas:

.1 Prepare such that there is:

.1 No undercutting or reverse ridges on weld bead.

.2 No weld spatter on or adjacent to weld or other area to be painted.

.3 No sharp peaks or ridges along weld bead.

.2 Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

.6 Blast Cleaning Requirements:

.1 Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.

.2 Select type and size of abrasive to produce a surface profile that meets coating Manufacturer's recommendations for particular primer to be used.

.3 Use only dry blast cleaning methods.

.4 Do not reuse abrasive, except for designed recyclable systems.

.5 Meet applicable federal, provincial, and local air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.

.7 Post-Blast Cleaning and Other Cleaning Requirements:

.1 Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.

.2 Paint surfaces the same day they are blast cleaned. Reblast surfaces that have started to rust before they are coated.

3.4 Application

.1 General:

.1 The intention of these Specifications is for new interior and exterior metal and submerged metal surfaces to be painted, whether specifically mentioned or not, except as modified herein. Prime coat structural steel surfaces.

.2 Extent of Coating (Immersion): Coatings shall be applied to all internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.

.3 For coatings subject to immersion, obtain full cure for completed system. Consult coatings Manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.

.4 Apply coatings in accordance with paint manufacturer's Recommendations. Allow sufficient time between coats to assure thorough drying of previously applied paint.

.5 Paint units to be bolted together and to structures prior to assembly or installation.

.6 Where more than one (1) coat of a material is applied within a given system, alternate colour to provide a visual reference that the required number of coats have been applied.

.2 Shop Primed Surfaces:

.1 Schedule inspection with the Contract Administrator before shop primed items are delivered to Site.

.2 Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.

.3 For two-package or converted coatings, consult coatings Manufacturer for specific procedures as relates to Manufacturer's products.

.4 Prior to application of finish coats, clean shop primed surfaces free of dirt, oil, and grease and apply mist coat of specified primer, 1 mil dry film thickness.

.5 After welding, prepare and prime holdback areas as required for specified paint system. Apply primer in accordance with Manufacturer's instructions.

.3 Stripe Coating:

.1 Stripe coat all field welds, edges, angles, fasteners, and other irregular surfaces located inside tanks.

.2 Stripe coat shall consist of one coat, brush applied, to the coating thickness specified.

.3 Apply stripe coat between intermediate and final coats.

.4 Stripe coat colour shall contrast intermediate coat to allow visual verification of application.

.4 Film Thickness:

.1 Number of Coats: Minimum required without regard to coating thickness. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in Manufacturers' products, and atmospheric conditions.

.2 Maximum film build per coat shall not exceed coating Manufacturer's recommendations.

.3 Film Thickness Measurements and Electrical Inspection of Coated Surfaces:

.1 Perform with properly calibrated instruments.

.2 Recoat and repair as necessary for compliance with the Specifications.

.3 All coats are subject to inspection by the Contract Administrator and coating Manufacturer's representative.

.4 Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

.5 Thickness Testing:

.1 After repaired and recoated areas have dried sufficiently, final tests will be conducted by the Contract Administrator.

.2 Measure coating thickness specified in mils with a magnetic type dry film thickness gauge.

.3 Test finish coat for holidays and discontinuities with an electrical holiday detector, low voltage, wet sponge type.

.4 Check each coat for correct millage. Do not make measurement before a minimum of eight (8) hours after application of coating.

.5 Damaged Coatings, Pinholes, and Holidays:

.1 Feather edges and repair in accordance with recommendations of paint Manufacturer.

.2 Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.

.3 Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and colour-matched appearance.

.6 Unsatisfactory Application:

.1 If item has an improper finish colour, or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified colour and coverage. Obtain specific surface preparation information from coating manufacturer.

.2 Evidence of runs, bridges, shiners, laps, or other imperfections are causes for rejection.

.3 Repair defects in coating systems in accordance with written recommendations of coating manufacturer.

.4 Leave all staging up until the Contract Administrator has inspected surface or coating. Replace staging removed prior to approval by the Contract Administrator.

3.5 Field Quality Control

.1 Testing Gauges:

.1 Provide a magnetic type dry film thickness gauge to test coating thickness specified in millimetres, as Manufactured by Nordson Corp., Anaheim, CA, Mikrotest.

.2 Provide an electrical holiday detector, low voltage, wet sponge type to test finish coat, except zinc primer, high-build elastomeric coatings, and galvanizing, for holidays and discontinuities as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.

.2 Test all coated surfaces with a holiday detector in accordance with NACE RP0188. Coated surfaces shall be free of holidays.

3.6 Manufacturer's Services

.1 The coating Manufacturer's Representative shall be present at shop or Site as follows:

.1 On the first day of application of any coating.

.2 A minimum of two (2) additional inspection visits, each for a minimum of four (4) hours, in order to provide Form 102 Certificate of Satisfactory Installation.

.3 As required to resolve field problems attributable to, or associated with the Manufacturers' product.

3.7 Cleanup

.1 Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at the end of each day.

.2 Upon completion of the Work, remove staging, scaffolding, and containers from the Site or destroy in a legal manner.

.3 Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.8 Protective Coatings Systems

.1 System No. 1 Submerged or Embedded Metal-Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast (SP10)	Potable Grade, Polyamide Epoxy Coating	3 coats, 0.08mm MDFTPC (3 mils MDFTPC)

.1 Application Schedule:

.1 Use this system on all metal surfaces inside piping and tanks, including, but not limited to, steel plates and structural steel; interior and exterior surfaces of the inlet, outlet, and overflow piping; manhole covers; hatches; ladders; landings; couplings; and vents.

.2 Use this system on the exposed surfaces of direct buried and concrete encased steel pipe.

.3 Coating is not required for the bottom side of the floor plates.

.4 Provide full coating thickness to the top of all structural steel that will be covered by the roof plates, or otherwise shielded from full coating thickness, before the structural steel members are installed. Remove coating in areas to be welded.

.2 System No. 5 Exposed Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 10)	Polyamide, Anticorrosive Epoxy Primer (Beige Colour)	1 coat, 0.064mm MDFT (2.5 mils MDFT)
	Polyurethane Enamel	1 coat, 0.08mm MDFT (3 mils MDFT)

.1 Application Schedule: Use this system on exposed exterior metal surfaces of piping and tanks. For galvanized surfaces to be coated, reference System No. 10.

.2 Tank Coating Sequence Anticipated:

.1 Shop prime all surfaces of shell plates and roof and floor plates and structural steel associated with the exterior of the tank; hold back shop primer where required for field welding.

.2 Shop priming of galvanized steel surfaces is not required.

.3 After tank erection, abrasive blast welds (SP 10) and damaged areas; apply primer.

.4 Clean primed surfaces and brush blast.

.5 Apply mist coat of primer.

.6 Apply finish coats.

.7 Touch up as required.

.3 System No. 6 Exposed Metal-Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
Abrasive Blast, or Centrifugal Wheel Blast (SP 6)	Rust-Inhibitive Primer	1 coat, 0.05 mm MDFT (2 mils MDFT)
	Alkyd Enamel	2 coats, 0.1 mm MDFT (4 mils MDFT)

.1 Application Schedule: Use this system on exposed exterior metal surfaces of tanks. For galvanized surfaces to be coated, reference System No. 10.

.2 Tank Coating Sequence Anticipated:

.1 Shop prime all surfaces of shell plates and roof and floor plates and structural steel associated with the exterior of the tank; hold back shop primer where required for field welding.

.2 Shop priming of galvanized steel surfaces is not required.

.3 After tank erection, abrasive blast welds (SP 10) and damaged areas; apply primer.

.4 Clean primed surfaces and brush blast.

.5 Apply mist coat of primer.

.6 Apply finish coats.

.7 Touch up as required.

.4 System No. 10 Galvanized Metal Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1) Followed by Hand Tool (SP 2), Power Tool (SP 3), or Brushoff Blast (SP 7)	Wash primer or coating manufacturers' recommended primer followed by System No. 5	1 coat, 0.01 mm MDFT (0.4 mils MDFT)

.1 Application Schedule: Use on galvanized surfaces, including handrails and gratings, before application of System No. 5.

.2 Coating Sequence Anticipated:

.1 Clean galvanized surfaces.

.2 Apply primer.

.3 Apply intermediate and finish coats (See System No. 5).

END OF SECTION

PAINTING AND FINISHING – PROCESS MECHANICAL

1. GENERAL

1.1 Summary

.1 Comply with Division 1 - General Requirements.

.2 Refer to Colour Schedule in this Section for items to be painted.

1.2 References

.3 ASTM D 523-85 Test Method for Specular Gloss.

.4 Steel Structures Painting Manual Vol. 2 - Systems and Specifications published by S.S.P.C. - Steel Structures Painting Council, 1982.

1.3 Submittals

.1 List of materials: Prior to commencement of work, submit three copies of list with name of manufacturer, number, grade and quality of materials proposed for use on the Work.

.2 Product and safety data sheets: Submit three copies of data sheets for each product.

.3 Submit paint colour samples for approval.

1.4 Quality Assurance

.1 Prior to commencement of painting operations meet at Site with Manufacturer's Representative and with the Contract Administrator to review these Specifications, painting work to be done and following related items:

.1 Equipment use and servicing

.2 Material storage and application techniques

.3 Surface preparation and ambient temperature

.4 Inspection requirements

.5 Inspection reports

.6 Hold points or check points

.7 Safety requirements during application

.8 Mock-ups or samples of coatings in highly corrosive environment

.2 Submit report of alternative recommendations for adverse conditions encountered.

.3 Arrange with the paint manufacturer to visit the Site at intervals during the surface preparation and painting operations to insure that the proper surface preparation has been completed, the specified paint products are being used, the proper number of coats are being applied and the agreed finishing procedures are being used, and that the paint manufacturer regularly submits written reports.

.4 Field Sample

.1 A sample area located in the building will be designated by the Contract Administrator.

.2 Apply samples of finishes in the sample area in the presence of the Contract Administrator, Contractor and paint manufacturer. Apply the samples with the correct material, number of coats, colour, texture and degree of gloss required. Refinish if required, until acceptance is obtained.

.3 Leave test areas undisturbed until completion of the work. Accepted work in the test area will serve as a standard for similar work throughout the Work.

1.5 Site Conditions

.1 Do not paint exterior surfaces at temperatures below 10°C nor in rainy or high humidity weather. Avoid painting surfaces exposed to direct sun.

.1 Do not paint interior surfaces at temperatures under 10°C or on surfaces where condensation has or will form due to presence of high humidity and lack of proper ventilation.

.2 Comply with manufacturer's recommendations.

2. PRODUCTS

2.1 Materials

.1 Paint and related materials: Glidden Paints by ICI Paints (Canada) Inc.

.2 Protective coating system is based on materials manufactured by ICI Paints (Canada) Inc and represents standard of quality. Comparable systems by PPG Canada Inc., Sherwin-Williams Company are acceptable.

3. EXECUTION

3.1 Examination

.1 Examine surfaces which are to be finished.

.2 Report surfaces which are defective, or which cannot be prepared by usual sanding and cleaning. Report unsatisfactory Site and environmental conditions.

.3 Commence work after corrective work has been completed.

3.2 Preparation

.1 Commencement of work means acceptance of Site and substrate conditions.

.2 Protect work performed under separate Sections from paint splatter, overspray and accidental spill.

.3 Remove soiled and used rags, waste and empty containers from the building daily.

.4 Take precautions to prevent fire.

.5 Comply with instructions on paint manufacturer's Safety Data Sheets.

.6 Provide surface preparation in accordance with SSPC Manual Volume 2 - "Systems and Specifications", Chapter 2.

.7 Apply primer within 4 hours after surface preparation or as recommended by paint manufacturer. Comply with SSPC-PA-1 for application techniques, requirements and precautions.

.8 Comply with CAN/CGSB 85.10 and CAN/CGSB 85.100..

.9 Remove cover plates of service devices, surface hardware, frames of lighting fixtures and other obstructions and reinstall them after painting work is completed. Replace units damaged while performing work under this Contract.

.10 Clean surfaces to be finished from machine, tool or sanding marks, dust, grease, soiling, or any extraneous matter.

.11 Test surfaces for moisture content. Do not apply materials to substrate when moisture content, exceeds 12% as determined by accepted moisture testing device.

.12 Ferrous metal surfaces - Prepare in accordance with surface preparation specifications outlined by the "Steel Structures Painting Council". Use method indicated in appropriate Protective Coating System.

.13 Manufacturer's bituminous protective coating: Sandblast SSPC-SP-6 and shop prime with same primer specified for coating system.

.14 Shop welds: Sandblast in accordance with SSPC commercial type blasting SP-6. Remove weld flux and other surface contaminants.

.15 Field welds: Use hand wire brush followed by cleaning with solvent swab.

.16 Unpassivated galvanized metal and plain aluminum surfaces: Wash thoroughly with Trisodium Phosphate or Oakite 31 by Oakite Corp., Oakville, Ont., solution mixed in accordance with manufacturers printed instructions. Rinse thoroughly. Follow instructions on Product Data sheets.

.17 Galvanized surfaces that have been passivated: On small areas use abrasive buffing with bronze wool pad SP-2 or power wire-brush SP-3 and clean with solvent. On large areas use brush-off blast SP-7 and clean with solvent.

.18 Concrete surfaces: Remove mold release oil with Xylol. If smooth etch for better adhesion. Follow instructions on Product Data sheets.

.19 Surfaces primed by item manufacturer: Prepare in accordance with Manufacturer's recommendations.

.20 Factory finished surfaces: Sand down for adhesion.

.21 Copper surfaces: Solvent clean and buff.

.22 Fabric jacketted surfaces: Clean of dust. Follow Manufacturer's instructions.

.23 PVC Pipe: Sand by hand surfaces to be coated to provide tooth for the coating system. Use a medium grit sandpaper. Clean with detergent solution prior to painting and allow to dry. Apply PVC cleaner/primer liberally with brush or soft lint-free cloth. Allow 15 minutes to dry and then paint immediately.

3.3 Application

.1 Apply paint materials free from defects.

.2 Mask surfaces where necessary, to prevent contamination or marring of adjacent material, or different protective coating system.

.3 Prevent overspray onto adjacent surfaces or properties.

.4 Do not apply paint over sealant.

.5 Verify that fabric jacketted pipes and ducts have been sized prior to painting.

.6 Confirm piping and ducting systems have successfully passed tests specified, prior to painting.

.7 For PVC piping, do not paint flanges, unions, coupling and valves.

3.4 Application Over Shop Painted Metal Surfaces and Touch-Up

.1 Check existing paint coatings for compatibility with paint with which they are to be overcoated.

.2 Clean areas to be painted using appropriate method.

.3 Minimum coating requirements for touch-up painting:

.1 No rusting but prime coat exposed: Sand lightly and feather edges. Apply 1 to 2 finish coats to regain specified minimum dry film thickness.

.2 No rusting but prime coat damaged: Clean area to base material, sand lightly and feather edges. Apply prime and finish coats. Sand and feather edges between coats.

.3 Rust areas: Clean to original standard of surface preparation. Apply coats as per 2. above. Apply spot finish coat(s) to uniform appearance.

3.5 Items to be Painted

.1 Equipment Items

.1 Paint all shop-primed items installed by Contractor.

.2 Do not paint bronze or brass surfaces.

.3 Do not paint stainless steel and aluminum surfaces unless called for in Colour Schedule.

.2 Piping (Process and Service)

.1 Paint piping, pipe supports, valves, valve operator and appurtenances except:

.1 Aluminum jacket

.2 PVC jacket

.3 Stainless steel

.4 Do not paint copper piping in concealed areas such as ceiling spaces.

.5 Do not paint galvanized steel non-exposed supports in the Administration area.

.2 Do not paint FRP ducts.

.3 Ductwork (HVAC)

.1 Do not paint HVAC ductwork.

.2 Do not paint canvas jacketed insulation.

.4 Touch up factory-painted surfaces on equipment and piping damaged during construction.

3.6 Application - General

.1 Apply finish coats of paint in thickness per coat specified.

.2 If minimum dry film thickness (DFT) in micrometres (microns) is not achieved, apply additional coat(s) until required thickness is obtained.

.3 Apply paint in accordance with SSPC Manual Volume 2 - "Systems and Specifications", Chapter 5.1.

.4 Sand semi-gloss, medium and high gloss finishes lightly between coats, unless otherwise approved by the coating manufacturer.

.5 Gloss terms of following values when tested in accordance with ASTM D523 Test for Specular Gloss:

Gloss Term	Gloss Value
Flat	5 to 20
Eggshell	20 to 40
Semi-gloss	40 to 60
Gloss, medium	60 to 80
Gloss, high	80 to 90

.6 Finish work uniformly as to sheen, gloss, colour and texture free from sags, runs and other defects and under adequate illumination.

.7 Apply materials in accordance with directions and instructions of manufacturers of materials. Do not use adulterants.

.8 Do not paint sprinkler heads, over ULC or other fire rating labels on doors and frames, nor over identification labels on mechanical and electrical equipment.

.9 High humidity atmosphere of more than 60% RH applies to following area(s):

.10 Corrosive material concentration: chemically corrosive atmosphere applies to following area(s):

.11 Steel and cast iron, service temperature 8-32 ^{o}C applies to following items:

.12 Steel and cast iron, service temperature 232-343^{o}C applies to following items:

.13 Steel and cast iron pipe under insulation below 83^{o}C applies to following items:

.14 Steel and cast iron pipe under insulation, above 83^{o}C applies to following items:

.15 Use applicable protective coating systems for these conditions as specified.

3.7 Schedule – Protective Coating Systems

By Glidden Paints By ICI Paints (Canada) Inc.

	SERVICE USE	PROTECTIVE COATING SYSTEM	SURFACE PREPA—RATION	NO. OF COATS	MIN. D.F.T. PER COAT IN MICRONS
.1	STRUCTURAL STEEL				
.1	Not receiving full protective coating system, concealed exposure	PRIME: Devguard 4160 (Red) Universal Primer	SP-6	1	50
		Devguard 4160 (Grey) Universal Primer		1	50
.2	STEEL & CAST IRON - EXTERIOR				
.1	Exterior exposure	PRIME: Devflex 4020 Acrylic Primer	SP-6	1	50-75
		FINISH: Devflex 4208 Series		2	38-50
.3	STEEL & CAST IRON				
.1	Low chemical, moisture and sulfide fume exposure	PRIME: Devguard 4160 (Red) Universal Primer	SP-6	1	50-60
		FINISH: Devguard 4308 Series Alkyd Modified Enamel		2	50
.2	High humidity, moisture, condensation, spray exposure	PRIME: Devguard 4160 (Red) Universal Primer	SP-6	1	50-60
		FINISH: Devshield 4328 Series Alkyd Modified Enamel		2	50
.3	Chemically corrosive	PRIME:			

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	exposure	Bar-Rust 235 Epoxy	SP-10	1	125-175
		FINISH:			
		Truglaze Epoxy 4508 Series		1	75-100
.4	Ground conditions - buried	COAT:			
		Devtar 5A Epoxy	SP-6	2	150-200
.4	STEEL & CAST IRON - HIGH TEMPERATURE				
.1	Service temperature up to 233°C	PRIME:			
		Devoe HT-4 Aluminum	SP-5	1	38-50
		FINISH:			
		Devoe HT-4 (Grey)		1	38-50
.2	Service temperature 150°C to 495°C	COAT:			
		Devoe HT-10 Aluminum	SP-10	2	25
.3	Steel, cast iron pipe under insulation - up to 83°C	COAT:			
		Catha-Coat 302 Zinc-rich Primer	SP-6	1	75-100
.4	Steel, cast iron up to 150°C	COAT:			
		Catha-Coat 336 Zinc-organic	SP-6	1	75
		FINISH:			
		Devoe HT-4 (Light Colours only)		1	38-50
.5	STEEL & CAST IRON & DUCTILE IRON - SUBMERGED				
.1	Totally or partially submerged in wastewater	SHOP PRIME:			
		Bar-Rust 235 Epoxy Off-White	SP-10	1	150-200
		FINISH:			
		Bar-Rust 235 Epoxy Grey	SP-10	1	150-200
.2	Totally or partially submerged in potable water	PRIME:			
		Bar-Rust 233H Epoxy, Buff	SP-10	1	125-150
		FINISH:			
		Bar-Rust 233 Epoxy Off-White		1	125-150
.6	DUCTILE IRON				

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.1	Low chemical, moisture and sulfide fume exposure	PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devguard 4308 Series Alkyd Gloss Enamel	SP-6	1 2	50-60 50
.2	High humidity, moisture, condensation, spray exposure	PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devshield 4328 Series Alkyd Modified Enamel	SP-2/SP-3	1 2	50-60 50
.3	Ground conditions - buried	COAT: Bar-Rust 235 Epoxy	SP-10	1	150-200
.4	Chemically corrosive atmosphere, fumes, and spills exposure	PRIME: Bar-Rust 235 Epoxy FINISH: Thruglaze Epoxy 4508 Series	SP-10	1 1	125-175 75-100
.7	GALVANIZED STEEL - INTERIOR				
.1	Low chemical, moisture and sulfide fume exposure	PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devguard 4308 Series Alkyd Gloss Enamel	SP-7	1 2	50-60 50
.2	High humidity, moisture, condensation, spray exposure	PRIME: Devran 4170 Epoxy Primer FINISH: Truglaze Epoxy 4508 Series	SP-7	1 2	75-100 50-75

PAINTING AND FINISHING – PROCESS MECHANICAL

.3	Chemically corrosive exposure	PRIME: Bar-Rust 235 Epoxy FINISH: Truglaze Epoxy 4508 Series	SP-7	1 1	125-150 75-100
.8	GALVANIZED STEEL - EXTERIOR				
.1	Exterior conditions	PRIME: Devguard 4160 (red) Universal Primer FINISH: Devguard 4308 Alkyd Gloss Enamel or Devflex 4208 Series	SP-7	1 2 2	50-60 50 38-50
.2	Chemically corrosive exposure	PRIME: Devran 4170 Epoxy Primer INTERMEDIATE:Devran 224 HS Epoxy 75% Solids – Grey FINISH: Devran 224 HS Epoxy 75% Solids – Tinted	SP-7	 1 1	75-100 75-100 75-100
.9	GALVANIZED STEEL - SUBMERGED				
.1	Totally or partially submerged in wastewater	PRIME: Bar-Rust 235 Epoxy Off-White FINISH: Bar-Rust 235 Epoxy Grey	SP-7	1 1	150-200 150-200
.2	Totally or partially submerged in potable water	PRIME: Bar-Rust 233 H Epoxy, Buff FINISH: Bar-Rust 233 H Epoxy, Off-White	SP-7	1 1	125-150 125-150

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.10 BITUMINOUS COATED SURFACES

.1	Non-submerged and non-severe service exposure	PRIME: Ultra Hide 275 Stain Stopper FINISH: Devguard 4308 Series Alkyd Gloss Enamel	SP-2/SP-3	2 2	25 50
.2	Non-submerged, high humidity, moisture, condensation, spray	PRIME: Ultra Hide 275 Stain Stopper FINISH: Devshield 4328 Series Alkyd Modified Enamel	SP-2/SP-3	2 2	25 50
.3	Submerged service in wastewater	PRIME: Bar-Rust 235 Epoxy Off-White FINISH: Bar-Rust 235 Epoxy Grey	SP-10	1 1	150-200 150-200

.11 FABRIC JACKET & POROUS INSULATION SURFACES

.1	Non-submerged and non-severe service	PRIME: Insul-Aid 5116 Primer-Sealer FINISH: Devguard 4308 Series Alkyd Gloss Enamel	See Art. 3.2	1 2	38 50
.2	High humidity, moisture, condensation, spray	PRIME: Insul-Aid 5116 Primer-Sealer FINISH: Devguard 4328 Series Alkyd Modified Enamel	See Art. 3.2	1 2	38 50

.12 MISCELLANEOUS SURFACES

.1	Exposed copper piping and tubing	Guardsman 6550-00390 clear lacquer	SP-1 and buff	1	38

PAINTING AND FINISHING – PROCESS MECHANICAL

.2	Plywood, wood, wood fiber panels, wood doors	PRIME: Ultra 9431-0 Undercoater FINISH: Ultra 9440-0 Series Alkyd Enamel Semi-gloss or Lifemaster 2000 Series 10 800 Series Semi-gloss	See Art. 3.2	1 2*	38-50 38-50

* apply minimum of three coats in a cross-hatch pattern on wood fibre panels.

.3	Wood exterior	PRIME: Ultra 9421-0 Wood primer FINISH: Devflex 4208 Series	Sand	1 2	38-50 38-50
.4	Wood - natural finish	FINISH: Urethane Varnish 334 333 Semi-gloss 332 Gloss	See Art. 3.2	2	38
.5	Factory finished steel items - non-severe service	PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devguard 4308 Series Alkyd Gloss Enamel	See Art. 3.2	1 2	50-60 50
.6	Factory finished items - high humidity exposure	PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devguard 4328 Series Alkyd Modified Enamel	See Art. 3.2	1 2	50-60 50
.7	Aluminum sheet and	PRIME:			

	aluminum closures and trim	Devguard 4160 (White) Universal Primer FINISH: Devguard 4308 Series Alkyd Gloss Enamel	SP-6	1 2	50-60 50
.8	FRP ducts	FINISH: Devran 224 HS Epoxy 75% Solids – Tinted 79-18	Light Sanding	1	75-100
.9	Aluminum surfaces unless prefinished for corrosive exposure	PRIME: Devran 4170 Epoxy Primer FINISH: Tru-Glaze Epoxy 4508 Series OR PRIME: Devguard 4160 (Red) Universal Primer FINISH: Devflex 4208 Series	SP-1/ SP-7 SP-6	1 1 1 2	75-100 75-100 50-60 38-50
.10	PVC Piping	PRIME: Devran 4170 Epoxy Primer FINISH: Devguard 4308 Series Alkyd Gloss Enamel Applied 24 Hours After Epoxy Primer	See Art. 3.2	1 2	75-100 50

3.8 Colour Schedule - General

.1 Colour numbers shown are from current brochures of manufacturers of materials.

.2 Unless otherwise indicated, colour for:

.1 items subjected to elevated temperatures in service (valves, expansion joints, exposed parts of insulated piping, exposed parts of insulated equipment and similar items): Standard colour in appropriate protective coating system.

.2 items totally or partially submerged: Standard colour in appropriate protective coating system.

.3 items buried: Standard colour in appropriate protective coating system.

3.9 Colour Schedule – Equipment Items

.1 Aluminum cable trays: Unfinished.

.2 Electrical panels: Prefinished ANSI/ASA #61 Grey.

.3 Galvanized steel conduit: Prefinished ANSI/ASA #61 Grey.

3.10 Colour Schedule – Piping (Process and Building Service)

.1 Ferrous, bituminous coated, PVC, galvanized and fabric jacketted substrates: Paint full surface of pipe and accessories in accordance with the table below. For piping colours not shown in the table below, obtain colour information from the Contract Administrator.

Service	**Colour**
Natural Gas	
Aqua Ammonia	
Backwash Supply	
Backwash Wastewater	
Chilled Water	
Compressed Air	
Cooling Water	
Ferric Chloride	
Filter Influent	
Filtered Water	
Filter-to-Recycle	
Fire Protection	
Heating Water	
Liquid Oxygen	
Plant Service Water	
Plumbing Vents	
Polymer	
Potable Water	
Process Air	
Process Drain	
Process Overflows	
Raw Water	
Sample	
Sanitary Drain	
Sodium Hydroxide	
Sodium Hypochlorite	
Storm Water	

Service	**Colour**
Thickened Sludge	
Thickener Supernatant	
Notes 1. Colours not shown in the table above will be provide by the Contract Administrator.	

3.11 Colour Schedule – Miscellaneous

.1 Fan guards and motor guards: Red machinery enamel.

.2 Mechanical supports, piping supports: Black.

.3 Main and secondary control panels, factory finish acceptable.

END OF SECTION

EQUIPMENT GENERAL PROVISIONS

1. GENERAL

1.1 Background

.1 The City of Winnipeg treats and supplies potable water to a population of approximately 632,000 people. The source of supply for the City of Winnipeg is surface water originating from Shoal Lake. The water is chlorinated at the intake and is conveyed via an Aqueduct to the Deacon reservoir, located just east of the City. The Deacon reservoir consists of four (4) open cells and holds approximately fourteen (14) to twenty-eight (28) days supply for the City. Water is rechlorinated as it leaves the reservoir through two (2) branch Aqueducts. The Water Distribution System contains three (3) regional distribution reservoirs and pumping stations.

.2 The City of Winnipeg wishes to enhance the treatment of its potable water. Currently the City is in the process of working toward the commissioning of ultraviolet (UV) disinfection equipment, which will be located after the Deacon reservoir to assist in inactivation of *Giardia* and *Cryptosporidium*.

.3 The treatment process will be further enhanced by the construction of a filtration plant. The new filtration plant will consist of coagulation with ferric chloride, flocculation, clarification using dissolved air flotation (DAF), ozonation, filtration, followed by disinfection using chlorine, UV light, and chloramination.

1.2 Requirements

.1 The provisions of this Section shall apply to all equipment except where otherwise indicated.

.2 Substantiating calculations and Drawings shall be provided at the time of submittal.

1.3 Reference Specifications, Codes, and Standards

.1 Equipment shall be in accordance with the latest edition of the following standards, as applicable and as indicated in each equipment Specification:

.1 American Gear Manufacturers Association (AGMA).

.2 American Society for Testing and Materials (ASTM).

.3 American National Standards Institute (ANSI).

.4 American Society of Mechanical Engineers (ASME).

.5 American Water Works Association (AWWA).

.6 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

.7 American Welding Society (AWS).

.8 National Fire Protection Association (NFPA).

.9 Federal Specifications (FS).

.10 National Electrical Manufacturers Association (NEMA).

.11 Manufacturer's published recommendations and Specifications.

.12 General Industry Safety Orders (OSHA).

.13 Canadian Standards Association (CSA).

.14 Underwriters Laboratories of Canada (ULC).

.2 The following standards are referenced in this Section:

.1 ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

.2 ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and other Special Alloys.

.3 ANSI B46.1 - Surface Texture.

.4 ASME B1.20.1 - General Purpose Pipe Threads (Inch).

.5 ASME B31.1 - Power Piping.

.6 AWWA C206 - Field Welding of Steel Water Pipe.

.7 AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm).

.8 AWWA D100 - Welded Steel Tanks for Water Storage.

.9 ASTM A 48 - Gray Iron Castings.

.10 ASTM A 108 - Steel Bars, Carbon, Cold-Finished, Standard Quality.

1.4 Contractor Submittals

.1 Shop Drawings: Furnish submittals in accordance with Section 01300 - Submittals.

.2 Equipment Installation: Complete all documentation as required within Section 01650 – Equipment Installation.

.3 Manuals: Provide manuals as specified within Section 01730 – Operation & Maintenance Manuals.

.4 Spare Parts List: A spare parts list complete with the name, address, and telephone number of the nearest distributor for each piece of equipment shall be provided. Include current prices for each spare part.

1.5 Quality Assurance

.1 Costs: Pay all costs of inspection, testing, adjustment, and instruction services performed by Manufacturer's representatives. The City will pay for power and water.

.2 Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

.1 Machine Work shall in all cases be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members without milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1.5 mm for members 10 m or less in length, and not greater than 3 mm for members over 10 m in length.

.2 Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5% of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures.

.3 All materials shall meet the physical and mechanical properties in accordance with the reference standards.

.3 Machine Finish: The type of finish shall be the most suitable for the application and shall be shown in micro-inches in accordance with ANSI B46.1. The following finishes shall be used:

.1 Surface roughness not greater than 1.575 microns shall be required for all surfaces in sliding contact.

.2 Surface roughness not greater than 6.25 microns shall be required for surfaces in contact where a tight joint is not required.

.3 Rough finish not greater than 12.5 microns shall be required for other machined surfaces.

.4 Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 0.8 microns.

2. PRODUCTS

2.1 General Requirements

.1 Noise Level: When in operation, no single piece of equipment shall exceed the OSHA noise level requirement of 85 dBA for one (1) hour exposure per day.

.2 Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. All components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque, speed, and horsepower. All of the applicable service factors shall be considered, such as mechanical motors, load class, start frequency, ventilation, ambient temperature, and fan factors. Drive train components include couplings, shafts, gears and gear drives, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	Service Factor	Load Classification
Blowers		
centrifugal or vane	1.0	Uniform
lobe	1.25	Moderate Shock
Pumps		
centrifugal or rotary	1.0	Uniform
progressing cavity	1.0	Uniform
Mixers		
Mixer/agitator	1.25	Moderate Shock

.3 Mechanical Service Factors

	Mechanical Service Factors
	Electric Motor
Uniform	1.25
Moderate Shock	1.50
Heavy Shock	2.00

.4 For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to gear Manufacturer sizing information.

.5 Where load classifications are not indicated, service factors based on AGMA 514.02 shall be used for standard load classifications and service factors for flexible couplings.

.6 Welding: Unless otherwise indicated, welding shall conform to the following:

.1 Latest revision of AWWA D100.

.2 Latest revision of AWWA C206.

.3 Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent entrance of air or moisture.

.4 Welding shall be by the metal-arc method or gas-shielded arc method as described in the AWS "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

.5 In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a workmanlike appearance, with uniform weld contours and dimensions. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 0.8 mm ($^{1}/_{32}$-inch) on the flat.

.7 Protective Coating: Equipment shall be painted or coated as specified within each equipment Specification unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with food grade grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

.8 Protection of Equipment: Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry at all times. Equipment delivered to the Site with rust or corroded parts shall be rejected.

.9 Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per Manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

.10 Controls: Equipment and system controls shall be in accordance with Division 17 - Instrumentation.

2.2 Equipment Supports

.1 Equipment Supports: Unless otherwise indicated, equipment supports, anchors, and restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greater of: that noted in the general structural notes or as required by the governing building code, or 10% of gravity. Submitted design calculations for equipment supports shall bear the signature and seal of an engineer registered in Manitoba, unless otherwise indicated.

2.3 Couplings

.1 Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise indicated or recommended by the Manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	Coupling Type
Direct or driven pumps	Gear or flexible spring
Single stage centrifugal blowers	Flexible disc pack

.2 Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The equipment Manufacturer shall select or recommend the size and type of coupling required to suit each specific application.

.3 Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, two (2) sets of universal type couplings shall be provided.

.4 Taper-Lock or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.4 Shafting

.1 General: Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

.2 Design Criteria: All shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications, in accordance with ASME B106.1M, - Design of Transmission Shafting. Where shafts are subjected to fatigue stresses, such as frequent start and stop cycles, the mean stress shall be determined by using the modified Goodman Diagram. The maximum torsional stress shall not exceed the endurance limit of the shaft after application of the factor of safety of two (2) in the endurance limit and the stress concentration factor of the fillets in the shaft and keyway. Stress concentration factor shall be in accordance with ASME Standard B17.1 - Keys and Keyseats.

.3 Materials: Shafting materials shall be appropriate for the type of service and torque transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

.1 Low carbon cold-rolled steel shafting shall conform to ASTM A108, Grade 1018.

.2 Medium carbon cold-rolled shafting shall conform to ASTM A108, Grade 1045.

.3 Other grades of carbon steel alloys shall be suitable for service and load.

.4 Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

.4 Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, a shaft of sufficient length with two (2) sets of universal type couplings shall be provided.

2.5 Gears & Gear Drives

.1 Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94%. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used.

.2 Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather to allow air to escape but keep dust and dirt out. The casing shall be of cast iron or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

.3 Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

.4 Material selections shall be left to the discretion of the Manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have two (2) positive seals to prevent oil leakage.

.5 Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with all required appurtenances shall be provided when necessary.

.6 Where gear drive input or output shafts from one Manufacturer connect to couplings or sprockets from a different Manufacturer, gear drive Manufacturer shall furnish a matching key taped to the shaft for shipment.

.7 Protect process streams from oil and grease leaks/spills.

2.6 Drive Chains

.1 Power drive chains shall be commercial type roller chains meeting ANSI Standards.

.2 A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

.3 A minimum of one (1) connecting or coupler link shall be provided in each length of roller chain.

.4 Chain and attachments shall be of the Manufacturer's best standard material and be suitable for the process fluid.

2.7 Sprockets

.1 General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

.2 Materials: Unless otherwise indicated, materials shall be as follows:

.1 Sprockets with twenty-five (25) teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45% carbon range.

.2 Type A and B sprockets with twenty-six (26) teeth or more, normally used as driven sprockets, shall be made of minimum 0.20% carbon steel.

.3 Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A48, Class 30.

.3 Sprockets shall be accurately machined to ANSI Standards. Sprockets shall have deep hardness penetration in tooth Sections.

.4 Finish bored sprockets shall be furnished complete with keyseat and set screws.

.5 To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

.6 Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.8 V-Belt Drives

.1 V-belts and sheaves shall be of the best commercial grade and shall conform to ANSI, Mechanical Power Transmission Association (MPTA), and Rubber Manufacturer’s Association (RMA) Standards.

.2 Unless otherwise indicated, sheaves shall be machined from the finest quality grey cast iron.

.3 Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

.4 To facilitate installation and disassembly, sheaves shall be provided complete with Taper-Lock or QD bushings as required.

.5 Finish bored sheaves shall be complete with keyseat and set screws.

.6 Sliding motor bases shall be provided to adjust the tension of V-belts.

2.9 Bearings

.1 General: Bearings shall conform to the standards of the Anti-Friction Bearing Manufacturers Association, Inc. (AFBMA).

.2 To assure satisfactory bearing application, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

.3 Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

.4 Lubricated-for-life bearings shall be factory-lubricated with the Manufacturer's recommended grease to insure maximum bearing life and best performance.

.5 Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of five (5) years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	Design Life (years)	L-10 Design Life (hours)
	(whichever comes first)	
8 hour shift	10	20,000
16 hour shift	10	40,000
Continuous	10	60,000

.6 Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the Manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

.7 Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing Manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing Manufacturer.

.8 Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the

Manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, the Manufacturer shall provide necessary piping, filters, and valves.

.9 Protect process streams from oil and grease leaks/spills.

2.10 Piping Connections

.1 Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment.

.2 Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ANSI B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ANSI/ASME B1.20.1.

.3 Flexible Connectors: Flexible connectors shall be provided in all piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

.4 Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used.

2.11 Gaskets and Packings

.1 Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane "Everseal".

2.12 Nameplates

.1 Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the Manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.13 Tools and Spare Parts

.1 Tools: Furnish one (1) complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling of all supplied equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional Work and manufactured by Snap On, Crescent, Stanley, or approved equal. The set of tools shall be neatly mounted in a labelled toolbox of suitable design provided with a hinged cover.

.2 Spare parts shall be furnished as indicated in the individual equipment Sections. All spare parts shall be suitably packaged in a metal box and labelled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.14 Equipment Lubricants

.1 Install food grade lubricants for all equipment during storage and prior to initial testing of the equipment.

3. EXECUTION

3.1 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

3.2 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.3 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that all equipment, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.4 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

END OF SECTION

RAW WATER PUMP INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 515-2005.

.2 The Contractor shall comply with all Division 1 requirements.

.3 The Contractor shall supply and install all components, piping, wiring, connections, accessories, etc. as specified in the Contract Documents required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the Raw Water Pumps as set forth in Bid Opportunity No. 515-2005. The raw water pumps including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

.5 Conform to Manufacturer's instructions for pump, motor and VSD installation.

1.2 Work by Contractor

.1 This Section covers the Work necessary by the Contractor to install the Raw Water Pumping equipment as described in Bid Opportunity No. 515-2005.

.2 Unloading and installation of the furnished equipment and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor.

.3 All vertical pumps, motors, VSDs (Magnadrives), electric actuators, pump columns, shafts, and supporting frames.

.4 All external conduit and wiring between separate equipment, shall be supplied and installed by Division 16.

.5 The Contractor shall touch-up any shipping or installation damage to the finish, following installation.

.6 Concrete equipment pads and grouting.

.7 Performance verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and furnishing a complete pump arrangement, and for coordination of all major equipment components. This includes, but is not limited to, proper sizing, testing, and performance of all pump components. There are a total of four (4) pump arrangements each including, but not be limited to, the following:

.1 186 kW Motor

.2 Mixed flow vertical pump

.3 Pump suction column

.4 Pump discharge head

.5 Pump shaft

.6 MagnaDrive VSD

.7 Electric actuator

.8 Temperature transmitters, speed and vibration sensors

.9 Enclosures

.2 Supply Contractor to provide services for the Raw Water Pumping Equipment Performance Testing and services including installation support, inspection, equipment testing, start-up, installation certification, and training of City personnel.

1.4 References

.1 Install the Raw Water Pumping equipment to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 ANSI

.2 ASME

.3 ASTM

.4 Canadian Electrical Code

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 AWWA

.7 AWS

.8 CSA

.9 ESA

.10 ISA

.11 NFPA

.12 EEMAC

.13 Local codes, by-laws, and regulations

.14 NEMA

.2 Specific regulations for each equipment package are listed within the individual Specifications.

1.5 Submittals

.1 Complete all documentation in accordance with Section 01210 – City Supplied Equipment

2. PRODUCTS

2.1 Electrical

.1 All electrical Work shall comply with requirements of Division 16 and 17.

2.2 Mechanical

.1 All mechanical Work shall comply with requirements of Divisions 9, 11, and 15.

.2 Piping shall comply with requirements of Section 15200 – Process Piping, including all Subsections.

.3 Valves shall comply with requirements of Section 15202 – Process Valves and Operators.

.4 All valves shall include factory-mounted operator, actuator, hand wheel, chain wheel, and accessories for a complete operation. All manual valves mounted 1.8 m above finished floor shall have operator extensions or chains located at an elevation of 1.2 m from the finished floor.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.1 The Raw Water Pumping equipment shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 The Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment shall be received by the Contractor at the City Warehouse, in accordance with the Project Master Schedule. The Contract Administrator will arrange for a representative of the Supply Contractor to be present at the City Warehouse during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide On-Site instruction for unloading of the Motors, Pumps, MagnaDrives, and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the Raw Water Pumping Equipment, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of WTP personnel.

.5 Do not route water piping directly above power supply units.

.6 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 m above finished floor. Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 m from the finished floor.

3.2 Raw Water Pumping Equipment

.1 The Supply Contractor will provide printed instructions for installation of all equipment to the Contractor.

3.3 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 1, including but not limited to Section 01210 – City Supplied Equipment, Section 01664 – Training, and Section 01670 – Commissioning.

END OF SECTION

DAF SYSTEM INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 154-2005.

.2 The Contractor shall comply with all Division 1 requirements.

.3 The Contractor shall supply and install all components, piping, wiring, connections, accessories, etc. as specified in the Contract Documents required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the DAF system as set forth in Bid Opportunity No. 154-2005. The DAF system including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the work necessary by the Contractor to install, the DAF system described in Bid Opportunity No. 154-2005.

.2 Unloading and installation of the furnished equipment and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor, such as installation of the flocculators, DAF skimmers, recycle pumps, compressors, saturators, laterals, spray wash headers.

.3 All compressed air piping between the air compressors, filters and saturators.

.4 All recycle system piping and valves between the DAF effluent channel, the recycle pumps, the saturator and the injection headers.

.5 All external conduit and wiring between separate equipment/skid packages, unless otherwise specified, shall be supplied and installed by Division 16.

.6 Concrete equipment pads and grouting.

.7 All non-skid-mounted isolation and process valves and instruments unless otherwise specified or shown on the Specifications.

.8 The Contractor shall touch-up any shipping or installation damage to the finish, following installation.

.9 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and supplying the DAF System as specified in Bid Opportunity No. 154-2005, and for coordination all major equipment components. This includes, but is not limited to, proper sizing, testing, and performance of all system components. The system will include, but not be limited to, the following:

.1 Flocculators.

.2 DAF Skimmers.

.3 Recycle Injection Headers and Nozzles

.4 Perforate Pipe Laterals

.5 Recycle Pumps.

.6 Saturator Systems including Vessels and Associated Instruments.

.7 Compressed Air Packages, including Oil Removal Filters.

.8 Complete DAF control system including all instruments, control panels/cabinets, as described in these documents.

.9 Automatic process valves.

.10 All piping, valving, wiring and instrumentation between components that are mounted within a common skid.

.2 The Supply Contractor will be responsible to provide PLC data signals between the DAF master control panel PLC and main WTP control system. The main WTP control strategy and the main WTP operator interface displays will be developed by others. The Supply Contractor shall coordinate with the Control System Integrator to develop and test the signal interface between the Supply Contractor supplied PLCs and the WTP control system.

.3 The Supply Contractor will provide all PLC and communication hardware including communication modules and industrial grade network switches for the DAF system.

.4 The Supply Contractor will provide services for DAF System Performance Testing and services including installation support, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Install the DAF system equipment to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 ANSI

.2 ASME

.3 ASTM

.4 Canadian Electrical Code

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 AWWA

.7 AWS

.8 CSA

.9 ESA

.10 ISA

.11 NFPA

.12 EEMAC

.13 Local codes, by-laws, and regulations.

.14 NEMA

.2 Specific regulations for each equipment package are listed within the individual Specifications.

1.5 Submittals

.1 Submittals shall be made as required in Section 01300 – Submittals. This includes but is not limited to the following:

.1 Support beams and legs including welding details, stamped by a Professional Engineer registered in the Province of Manitoba.

.2 Complete all documentation in accordance with Section 01210 – City Supplied Equipment

2. PRODUCTS

2.1 Electrical

.2 All electrical Work shall comply with requirements of Division 16 and 17.

2.2 Mechanical

.1 All mechanical Work shall comply with requirements of Divisions 9, 11, and 15.

.2 Piping shall comply with requirements of Section 15200 – Process Piping, including all subsections.

.3 Supply Contractor will shop-install all piping and tubing within each skid mounted assembly. Contractor shall provide and install all interconnecting piping as per Contract Drawings. Unless otherwise specified, provide valves that are the Manufacturer's standard, suitable for the intended service conditions.

.4 Valves shall comply with requirements of Section 15202 – Process Valves and Operators.

.5 All valves shall include factory-mounted operator, actuator, hand wheel, chain wheel, and accessories for a complete operation. All manual valves mounted 1.8 m above finished floor shall have operator extensions or chains located at an elevation of 1.2 m from the finished floor.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.1 The DAF system shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment shall be received, by the Contractor at the City Warehouse, in accordance with the Project Master Schedule. The Contract Administrator shall arrange for a representative of the Supply Contractor to be present at the City Warehouse during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide On-Site instruction for unloading of the floccculators, DAF skimmer, saturators, compressors, and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the DAF System Equipment, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of WTP personnel.

.5 Do not route water piping directly above power supply units.

.6 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 m above finished floor.

Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 m from the finished floor.

3.2 DAF System Equipment

.1 The Supply Contractor will provide printed instructions for installation of all equipment to the Contractor.

3.3 DAF Skimmer Support Beams and Legs

.1 The Contractor shall supply and install all DAF skimmer support beams and legs, as outlined in the Contract Drawings.

3.4 DAF Recycle System

.2 The Contractor shall supply and install all piping and valves between the DAF common channel and the recycle pumps, between the recycle pumps and the Saturator and between the Saturator and the recycle injection header isolation valves, as outlined in the Contract Drawings.

3.5 Saturator Vessel

.1 The Contractor shall install the saturator vessel, and associated instruments and accessories on the Saturator vessel as per Contract Drawings.

3.6 Compressed Air System

.1 The Contractor shall supply and install all piping between the compressor skids and the filters and between the filters and the saturators and pneumatic valves, as outlined in the Contract Drawings.

3.7 Spray Wash System

.1 The Contractor shall supply and install all piping between the WTP Service Water system and the spray wash system and install the spray wash system as per Contract Drawings.

3.8 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 1, including but not limited to Section 01210 – City Supplied Equipment, Section 01664 – Training, and Section 01670 – Commissioning.

END OF SECTION

FILTER MEDIA INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity # 427-2005 – Section 11201 – Filter Media.

.2 The Contractor shall comply with all Division 01 requirements.

.3 The Contractor shall supply and install all components, connections, accessories, etc. as specified in the Contract Documents, required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the granular activated carbon (GAC) filter media as set forth in Bid Opportunity # 427-2005. The filter media including, but not limited to the equipment specified, will be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the work necessary by the Contractor to coordinate installation of the filter media described in Bid Opportunity # 427-2005.

.2 Prior to filter media placement, the Contractor shall clean and disinfect entire filter area including filter box, underdrains, troughs and piping in accordance with the requirements of AWWA C652-02 for Disinfection of Water Systems. GAC media shall not be disinfected.

.3 Contractor is responsible for operating filter controls during backwashing and shall coordinate with Contract Administrator and Supply Contractor to ensure proper startup sequence is followed.

.4 Coordination and provision of Site utility services assistance for unloading and installation of the GAC filter media by the Supply Contractor.

.5 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for supplying the GAC filter media as specified in Bid Opportunity # 427-2005 – Section 11201 – Filter Media. This includes, but is not limited to, proper sizing, testing, and performance of GAC filter media.

.2 The Supply Contractor to provide services for GAC filter media unloading and installation as specified in Bid Opportunity # 427-2005 – Section 11201 – Filter Media as a wet slurry from the exterior of the building to the eight filter tanks inside the building.

.3 The Supply Contractor will provide samples and complete descriptive specifications for the proposed GAC filter media with submittals.

.4 The Supply Contractor will provide services for GAC filter media Performance Testing and services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Supply Contractor will install the filter media to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 American National Standards Institute (ANSI)

.2 American Society of Mechanical Engineer's (ASME)

.3 American Society for Testing and Materials (ASTM):

.4 Canadian Electrical Code (CEC).

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 American Water Works Association (AWWA) – B604.

.7 American Welding Society (AWS).

.8 Canadian Standards Association (CSA).

.9 Electrical Safety Authority (ESA).

.10 The Instrument, Systems and Automation Society (ISA).

.11 National Fire Protection Association (NFPA).

.12 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.13 Local codes, by-laws, and regulations.

.14 National Electrical Manufacturers Association (NEMA)

.2 Specific regulations for each package are listed within the individual Specifications.

1.5 Submittals

.1 Submittals by Contractor shall be made as required in Section 01300 – Submittals.

.1 Submit disinfection procedures for filter tanks, piping, and equipment.

.2 Submit planned procedures for commissioning sequence of filter operation for filter media installation.

.2 Submittals by Supply Contractor to be in accordance with requirements of Bid Opportunity #427-2005, Section 11201.

.3 Complete all documentation in accordance with Section 01650 – Equipment Installation, and 01210 – City Supplied Equipment.

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Divisions 16 and 17.

2.2 Mechanical

.1 All mechanical work shall comply with requirements of Divisions 9, 11 and 15.

3. EXECUTION

3.1 Delivery of Equipment and Installation - General

.1 The filter media will be installed by the Supply Contractor in accordance with the equipment Manufacturers' written recommendations and directions and requirements of Bid Opportunity #427-2005 – Section 11201. The Contractor and Contract Administrator may be present to oversee installation of the filter media by the Supply Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All filter media will be received at the City Warehouse, and then delivered to Site, unloaded and installed by the Supply Contractor in accordance with the Project Master Schedule. The Contractor shall arrange for a representative of the Contract Administrator to be present at the Site during the unloading to inspect the delivered filter media and witness the unloading process, and take samples as required. The Supply Contractor will notify the Contractor of any special items necessary for unloading, including water supply and drainage requirements as described in the Supply Contractor installation procedures submittal. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 The Supply Contractor will provide printed procedures as a Certified Shop Drawing submittal prior to delivery, for installation of all filter media to the Contractor and Contract Administrator.

3.2 Work by Contractor (included in this Contract)

.1 The following work related to the installation of the filter media shall be provided by the Contractor, and includes but is not limited to:

.1 Obtain necessary permits for work in confined areas. GAC depletes oxygen from air and can be hazardous in a confined situation.

.2 Prior to GAC placement, the Contractor shall clean and disinfect entire filter area including underdrains, troughs and piping in accordance with the requirements of AWWA C652-02 for Disinfection of Water Systems. GAC media shall not be disinfected.

.3 Do not permit workers to walk or stand directly on media. Use boards that will sustain workers' weight without displacing media.

.4 Form 103 for backwash pumps P-F911A/P-F921A, backwash area process sump pumps P-F981A/P-F982A/P-F983A/P-F984A, filter underdrains and troughs, WTP potable water and drainage system, and residuals backwash wastewater handling system must be completed and accepted in order to demonstrate acceptable backwash system performance prior to GAC filter media installation.

.5 Contractor is responsible for operating filter controls during backwashing and Performance Verification and shall coordinate with Contract Administrator and Supply Contractor to ensure proper startup sequence is followed.

3.3 Installation by Supply Contractor (included in Bid Opportunity #427-2005)

.1 Refer to installation requirements in Bid Opportunity #427-2005 – Section 11201 – Filter Media.

3.4 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 01, including but not limited to Section 01650 – Equipment Installation, Section 01664 – Training, Section 01670 – Commissioning, Section 01210 – City Supplied Equipment, and as outlined in Bid Opportunity # 427-2005.

.2 Supply Contractor will provide assistance during performance tests, document results, and provide instructions to the Contractor who will operate the equipment as required to perform tests.

END OF SECTION

FILTER UNDERDRAINS INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity # 427-2005 – Section 11203 – Filter Underdrains.

.2 The Contractor shall comply with all Division 01 requirements.

.3 The Contractor shall supply and install all components, connections, accessories, etc. as specified in the Contract Documents, required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the filter underdrains as set forth in Bid Opportunity # 427-2005. The filter underdrains including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the work necessary by the Contractor to install, the filter underdrains described in Bid Opportunity # 427-2005, Section 11203 – Filter Underdrains.

.2 Unloading and installation of the furnished filter underdrains and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor.

.3 Provide all materials, accessories and services required to install the filter underdrain system according to the Supply Contractor's Bid Opportunity #427-2005 submissions for scope of supply, written instructions, Shop Drawing Submittals, and Contract Drawings.

.4 The Contractor shall replace any shipping or installation damage, following installation.

.5 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and supplying filter underdrains as specified in Bid Opportunity # 427-2005 and for coordination of all major components. This includes, but is not limited to, proper sizing, testing, and performance of all components.

.2 The Supply Contractor will provide complete Shop Drawing submittals as specified in Bid Opportunity # 427-2005 and complete descriptive installation specifications for the filter underdrain system.

.3 The Supply Contractor will provide services for filter underdrains Performance Testing and services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Contractor shall install the filter underdrains to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 American National Standards Institute (ANSI)

.2 American Society of Mechanical Engineer's (ASME)

.3 American Society for Testing and Materials (ASTM):

.4 Canadian Electrical Code (CEC).

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 American Water Works Association (AWWA).

.7 American Welding Society (AWS).

.8 Canadian Standards Association (CSA).

.9 Electrical Safety Authority (ESA).

.10 The Instrument, Systems and Automation Society (ISA).

.11 National Fire Protection Association (NFPA).

.12 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.13 Local codes, by-laws, and regulations.

.14 National Electrical Manufacturers Association (NEMA)

.15 CAN/CSA A23.2-04: Methods of Test for Concrete

.2 Specific regulations for each package are listed within the individual Specifications.

1.5 Submittals

.1 Submittals by Contractor shall be made as required in Section 01300 – Submittals.

.1 Submit anchor system details with rated strength for underdrain pier support installations.

.2 Submit materials mill test certificates for rebar, anchor and metal products.

.3 Submit concrete mix design, and confirmation of acceptance by Supply Contractor.

.4 Submit concrete test results for plenum installation as per CAN/CSA A23.2-04.

.2 Submittals by Supply Contractor to be in accordance with requirements of Bid Opportunity #427-2005, Section 11203– Filter Underdrains.

.3 Complete all documentation in accordance with Section 01650 – Equipment Installation, and Section 01210 – City Supplied Equipment.

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Divisions 16 and 17.

2.2 Mechanical

.1 All mechanical work shall comply with requirements of Divisions 9, 11 and 15.

2.3 Nozzle Plenum Filter Underdrain System

.1 The filter underdrain will consist of a false concrete bottom in each filter cell supported above the true concrete bottom of the filter box. Supply Contractor will design and provide component parts for the underdrain system for eight (8) water filters, each 9000 millimetres wide by 9000 millimetres long as per Contract Drawings showing filter layout and piping configuration. Design criteria for concrete and reinforcement to be provided by Supply Contractor with Shop Drawings submittals, as per Bid opportunity #427-2005, Section 11203 – Filter Underdrains.

.2 The underdrain system shall be constructed onsite by the Contractor using corrosion resistant plastic underdrain forms, plastic underdrain nozzles, cylindrical PVC pier forms provided by the Manufacturer and cast-in-place reinforced concrete provided by the Contractor. Plastic concrete inserts will be provided by Supply Contractor which shall be field attached to the forms by the Contractor according to Supply Contractor instructions. Each insert will be provided with screwed plastic end protectors which will prevent concrete from entering the insert and will be removed after the concrete has set so that media retaining nozzles may be screwed into the insert.

.3 Underdrain forms and anchor/post grid will be nominally 600 millimetres (24 inches) square and designed by Supply Contractor to interlock with the pier forms. They will be designed to support the weight of the wet concrete and remain in place after the concrete has set.

.4 The Supply Contractor will provide filler forms to close the area along the perimeter walls where a full form cannot fit. The filler forms shall be cut to the appropriate size by the Contractor onsite to ensure accuracy.

.5 Pier form will be 150 millimetre (6-inches) diameter Schedule 80 PVC pipe notched, if required, to accept the underdrain form.

.6 Supply Contractor will design the concrete underdrain slab and pier reinforcement with 10M or 15M reinforcing steel bars. Reinforcement arrangement will be shown on the Shop Drawings prepared by the Supply Contractor.

.7 Supply Contractor will design and size the Type 316 stainless steel anchor bolts, c/w nuts and washers. Anchors embedded in concrete must be adhesive type.

.8 Type 316 stainless steel backwash air scour (AS) header pipes, 316 stainless steel perimeter angle, underdrain forms, concrete inserts, underdrain nozzles, insert end protector caps, pier forms, bar chairs, and general arrangement drawings will be by underdrain Supply Contractor. Reinforcing steel, concrete and ABS solvent shall be provided by the Contractor. Underdrain access manways shall be provided beside backwash pipe location by the Contractor that are 900 millimetre diameter.

.9 Underdrain Nozzles:

.1 The nozzles will be General Filter Model MCA as provided by the Supply Contractor equipped with a plastic tail pipe having properly sized orifices located at the bottom of the concrete underdrain slab to provide uniform distribution of air for air scour only, and for air during combined air/water. Nozzles will be constructed of high strength erosion resistant ABS plastic. The nozzles will be of the slotted type wherein the slots lie in a horizontal plane so that the backwash water is uniformly discharged horizontally into the filter media. The slot dimensions will be designed to present sharp edges to the retained media. The slots in the nozzles will be designed to get progressively larger toward the inside of the assembly to prevent loading of media in the slot. Hardware will be stainless steel and shall be limited to bolts, nuts and washers and shall not be in contact with the distributor opening.

.2 Supply Contractor will provide 150 extra nozzles as spare parts.

.10 Air Scour Piping:

.1 Supply Contractor will design and provide each filter cell with air scour piping within the basin proper to ensure uniform distribution of air during backwash.

.2 The air scour piping layout within the basin will be butt welded as per design and supply of the Supply Contractor, but installed by the Contractor. An embedded wall pipe spool will be provided by the Contractor for flange connection of the air piping within the filter plenum.

.3 Materials of construction for the air scour piping and supporting hardware within the Filter Box area shall meet the requirements specified in Bid Opportunity #427-2005.

3. EXECUTION

3.1 Delivery of Equipment and Installation - General

.1 The filter underdrains shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment will be received at the City Warehouse, delivered to Site, uncrated, and installed by the Contractor in accordance with the Project Master Schedule. The Contractor shall arrange for a representative of the Supply Contractor to be present at the Site during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide on-site instruction for unloading of the filter underdrains and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the filter underdrains, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 The Supply Contractor will provide printed instructions as a Certified Shop Drawing for installation of all filter underdrains to the Contractor.

3.2 Installation by Contractor

.1 Installation of the nozzle plenum filter underdrain system will be by the Contractor in accordance with the Manufacturer's instructions. Installation includes but is not limited to:

.1 General: Install the filter underdrain systems in strict accordance with the Manufacturer's installation instructions, Certified Shop Drawings and printed recommendations, and as specified. Obtain from the underdrain Manufacturer such written installation details, recommendations, and training required to acceptably interface the filter underdrain system with all surrounding structures, including any requirement for grouting keys and pockets, dowels, support ledges and piers, anchorage, etc. Prepare the false floor support forms and piers as necessary to enable installation within the required level tolerance.

.2 Coordinate the placement of the monolithic cast-in-place concrete slab and piers with the Manufacturer. The concrete structural slab shall be finished to a true and level plane within the lesser of plus or minus 3.2 millimetre (1/8 inch) or the tolerance specified by the Manufacturer of the filter underdrain. Failure of the filter underdrain system to meet the level tolerances shall require removal of the failed sections and replacement with new underdrain sections to within level tolerances.

.3 Should any underdrain material, including the false floor forms, nozzle inserts, and nozzles become chipped, plugged, bent or damaged in any way, they shall be removed

and replaced before the false floor concrete is placed. Pull out testing of anchors will be completed before underdrains are assembled and concrete is placed.

.4 Before installation of the filter media, the Contractor shall vacuum clean the underdrain area, all cell effluent and backwash supply piping, and all surfaces that come into contact with the backwash supply water. All air supply piping shall be thoroughly cleaned and flushed with air only. The Contract Administrator and filter underdrain Supply Contractor must approve this cleaning before the filter media Supply Contractor can proceed with installation of the filter media.

.5 Form 103 for backwash pumps P-F911A/P-F921A, backwash area process sump pumps P-F981A/P-F982A/P-F983A/P-F984A, filter underdrains and troughs, WTP potable water and drainage system, and residuals backwash wastewater handling system must be completed and accepted in order to demonstrate acceptable backwash system performance prior to GAC filter media installation.

.6 Contractor is responsible for operating filter controls during backwashing and Performance Verification and shall coordinate with Contract Administrator and Supply Contractor to ensure proper startup sequence is followed.

3.3 Supply Contractor's Field Services

.1 Refer to installation requirements in Bid Opportunity #427-2005 – Section 11203 – Filter Underdrains.

3.4 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 01, including but not limited to Section 01650 – Equipment Installation, Section 01664 – Training, and Section 01670 – Commissioning, 01210 – City Supplied Equipment, and as outlined in Bid Opportunity # 427-2005.

.2 The Supply Contractor will provide coordination for performance tests, document results and provide instructions to the Contractor who will operate the equipment as required to perform tests.

END OF SECTION

FILTER TROUGHS INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity # 427-2005 – Section 11205 – Filter Troughs.

.2 The Contractor shall comply with all Division 01 requirements.

.3 The Contractor shall supply and install all components, connections, accessories, etc. as specified in the Contract Documents, required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the filter troughs as set forth in Bid Opportunity # 427-2005. The filter troughs including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the work necessary by the Contractor to install, the filter troughs described in Bid Opportunity # 427-2005.

.2 Contractor shall unload and install the furnished filter troughs and accessories at the Site according to the Manufacturer's written instructions, Shop Drawing Submittals, and Contract Drawings.

.3 The Contractor shall replace any shipping or installation damage, following installation.

.4 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and supplying filter troughs as specified in Bid Opportunity # 427-2005and for coordination of all major components. This includes, but is not limited to, proper sizing, testing, and performance of all components.

.2 The Supply Contractor will provide complete Shop Drawing submittals as specified in Bid Opportunity # 427-2005 and complete descriptive installation specifications for the filter trough system.

.3 The Supply Contractor will provide services for filter troughs Performance Testing and services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Contractor to install the filter troughs to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 American National Standards Institute (ANSI)

.2 American Society of Mechanical Engineer's (ASME)

.3 American Society for Testing and Materials (ASTM):

.4 Canadian Electrical Code (CEC).

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 American Water Works Association (AWWA).

.7 American Welding Society (AWS).

.8 Canadian Standards Association (CSA).

.9 Electrical Safety Authority (ESA).

.10 The Instrument, Systems and Automation Society (ISA).

.11 National Fire Protection Association (NFPA).

.12 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.13 Local codes, by-laws, and regulations.

.14 National Electrical Manufacturers Association (NEMA)

.2 Specific regulations for each package are listed within the individual Specifications.

1.5 Submittals

.1 Submittals by Contractor shall be made as required in Section 01300 – Submittals.

.1 Submit grout product details for review.

.2 Submittals by Supply Contractor to be in accordance with requirements of Bid Opportunity #427-2005, Section 11205.

.3 Complete all documentation in accordance with Section 01650 – Equipment Installation, and Section 01210 – City Supplied Equipment.

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Divisions 16 and 17.

2.2 Mechanical

.1 All mechanical work shall comply with requirements of Divisions 9, 11 and 15.

2.3 Filter Troughs

.1 The Supply Contractor will provide five 316 stainless steel filter backwash troughs in each of eight filter cells (40 troughs total), including 316 stainless steel mounting brackets, supports and anchor bolts, Certified Shop Drawing Submittals, and Contract Drawings.

.2 The Contractor will provide non-ferrous grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, Grace In-Pakt Grout, minimum compressive strength 35 MPa, to seal the trough penetrations in the filter wall to the top of the trough weir elevation.

3. EXECUTION

3.1 Delivery of Equipment and Installation - General

.1 The filter troughs shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment will be received at the City Warehouse, delivered to Site, uncrated, and installed by the Contractor in accordance with the Project Master Schedule. The Contractor shall arrange for a representative of the Supply Contractor to be present at the Site during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide on-Site instruction for unloading of the filter troughs and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the filter troughs, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 The Supply Contractor will provide printed instructions for installation of all filter troughs to the Contractor.

3.2 Installation by Contractor

.1 Installation of the filter trough system will be by the Contractor in accordance with the Supply Contractor's instructions. Installation includes but is not limited to:

.1 All 316 Stainless steel trough mounting brackets, beams, hardware and stabilizers as as supplied by the Supply Contractor.

.2 Troughs shall be installed so that weir edges are level to within plus or minus 3.2 millimetres (or 1/8 inch) per 3 metres (or 10 feet) of length.

.3 Final elevation adjustment shall be performed by the Contractor after installation of the troughs using adjustable support rods and prior to grouting.

.4 No field welding shall be required or allowed for installation of the troughs.

.5 Disinfection: Refer to AWWA C-652-02 Disinfection of Water Systems for appropriate disinfection methods for pipes and tanks in drinking water systems.

.6 Form 103 for backwash pumps P-F911A/P-F921A, backwash area process sump pumps P-F981A/P-F982A/P-F983A/P-F984A, filter underdrains and troughs, WTP potable water and drainage system, and residuals backwash wastewater handling system must be completed and accepted in order to demonstrate acceptable backwash system performance prior to GAC filter media installation.

.7 Contractor is responsible for operating filter controls during backwashing and Performance Verification and shall coordinate with Contract Administrator and Supply Contractor to ensure proper startup sequence is followed.

3.3 Supply Contractor's Field Services

.1 Refer to installation requirements in Bid Opportunity #427-2005 – Section 11205 – Filter Troughs.

3.4 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 01, including but not limited to Section 01650 – Equipment Installation, Section 01664 – Training, Section 01670 – Commissioning, Section 01210 – City Supplied Equipment, and as outlined in Bid Opportunity # 427-2005.

.2 The Supply Contractor will provide coordination for performance tests, document results and provide instructions to the Contractor who will operate the equipment as required to perform tests.

END OF SECTION

OZONE SYSTEM INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 428-2005.

.2 The Contractor shall comply with all Division 01 requirements.

.3 The Contractor shall supply and install all components, piping, wiring, connections, accessories, etc. as specified in the Contract Documents, required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the ozone system as set forth in Bid Opportunity # 428-2005. The ozone system including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the work necessary by the Contractor to install, the ozone systems described in Bid Opportunity # 428-2005. The Contractor shall confirm receipt of all documents from the City's website.

.2 Unloading and installation of the furnished equipment and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor, such as installation of the dielectric tubes, transformers, and electrical power connections between the ozone generators and power supply units.

.3 All gas piping between oxygen gas filters; the pressure regulators and the ozone generators; and downstream of the generator skids to the ozone dissolution system.

.4 All off-skid cooling water piping and open loop cooling water pumps.

.5 The LOX storage and feed system will be supplied and installed by the City. The City will provide piping from LOX storage and feed system to a flanged connection located approximately 1.0 m outside of the building. GOX piping and accessories inside of the building as shown on the Contract Drawings and to the demarcation point 1.0 m outside of the building shall be supplied and installed by the Contractor. Confirm the location of the demarcation point with the Contract Administrator prior to installing any GOX piping.

.6 All control and power external conduit and wiring between separate equipment/skid packages, unless otherwise specified.

.7 Concrete equipment pads and grouting.

.8 All non-skid-mounted isolation and process valves and instruments unless otherwise specified or shown on the Specifications.

.9 The Contractor shall touch-up any shipping or installation damage to the finish, following installation.

.10 The Contractor shall clean all piping, valving, and all other equipment installed by the Contractor, in accordance with the Supply Contractor's written recommendations and directions and the applicable codes, standards, and regulations. Cleaning will not be required for piping, valving and equipment pre-cleaned by the Supply Contractor.

.11 Performance Verification assistance.

.12 Calibration of instruments not provided under Bid Opportunity 428-2005 and control loop checks for items not controlled by Supply Contractor.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and furnishing a complete system, and for coordination all major equipment components. This includes, but is not limited to, proper sizing, testing, and performance of all system components. The system shall include, but not be limited to, the following:

.1 Ozone generators.

.2 Power supply units.

.3 Ozone master control panel.

.4 Particulate filters.

.5 Nitrogen boost skid.

.6 Cooling water system(s).

.7 Ozone dissolution system.

.8 Off-gas demisters.

.9 Off-gas pressure and vacuum relief valves.

.10 Ozone destruct units.

.11 Off-gas blowers.

.12 Complete ozone control system including all instruments, control panels/cabinets, as described in these documents.

.13 Automatic process valves.

.14 All piping, valving, wiring and instrumentation between components that are mounted within a common skid.

.2 Calibration of all instruments provided under Bid Opportunity 428-2005 and all control loop checks for Supply Contractor controlled items.

.3 The Supply Contractor will be responsible to provide PLC data signals between the ozone master control panel PLC and main WTP control system. The main WTP control strategy and the main WTP operator interface displays will be developed by others. The Supply Contractor shall coordinate with the Control System Integrator to develop and test the signal interface between the Supply Contractor supplied PLCs and the WTP control system.

.4 The Supply Contractor will supply all PLC and communication hardware including communication modules and industrial grade network switches for the ozone system.

.5 Supply Contractor to provide services for Ozone System Performance Testing and services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Install the ozone system equipment to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 American National Standards Institute (ANSI)

.2 American Society of Mechanical Engineer's (ASME)

.3 American Society for Testing and Materials (ASTM):

.4 Compressed Gas Association (CGA): Pamphlet G-4.1, "Cleaning Equipment for Oxygen Service".

.5 Canadian Electrical Code (CEC).

.6 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.7 American Water Works Association (AWWA).

.8 American Welding Society (AWS).

.9 Canadian Standards Association (CSA).

.10 Electrical Safety Authority (ESA).

.11 The Instrument, Systems and Automation Society (ISA).

.12 National Fire Protection Association (NFPA).

.13 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.14 Local codes, by-laws, and regulations.

.15 National Electrical Manufacturers Association (NEMA)

.2 Specific regulations for each equipment package are listed within the individual Specifications.

1.5 Submittals

.1 Submittals shall be made as required in Section 01300 – Submittals.

.2 Complete all documentation in accordance with Section 01650 – Equipment Installation.

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Division 16 and 17.

.2 Motors shall be provided in accordance with Specification Sections 11301 and 11501.

2.2 Mechanical

.1 All mechanical work shall comply with requirements of Divisions 9, 11 and 15.

.2 Provide the open loop cooling water pumps in accordance with Section 11501 – Vertical In-line Centrifugal Pumps.

.3 Piping shall comply with requirements of Section 15200 – Process Piping, including all subsections.

.4 Supply Contractor will shop-install all piping and tubing within each skid mounted assembly. Contractor shall provide and install all interconnecting piping as per Contract Drawings. Unless otherwise specified, provide valves that are the Supply Contractor's standard, suitable for the intended service conditions.

.5 Provide the required control and instrumentation tubing, fittings, and valves for instruments of Type 316 stainless steel in accordance with the requirements specified in Div 17 and Part D.

.6 Valves shall comply with requirements of Section 15202 – Process Valves and Operators.

.7 All valves shall include factory-mounted operator, actuator, hand wheel, chain wheel, and accessories for a complete operation. All manual valves mounted 1.8 m above finished floor

shall have operator extensions or chains located at an elevation of 1.2 m from the finished floor.

.8 Piping, valving, and all other equipment in oxygen and ozone gas service shall be cleaned in compliance with the Compressed Gas Association (CGA) Pamphlet G4.1, "Cleaning Equipment for Oxygen Service," latest edition and shall be of suitable materials for the appropriate service.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.1 The ozone system shall be installed by the Contractor in accordance with the equipment Manufacturers' written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 - City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment will be received, uncrated, and installed by the Contractor at the Site, in accordance with the Contract Work Schedule. The Contract Administrator shall arrange for a representative of the Supply Contractor to be present at the Site during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide on-Site instruction for unloading of the ozone generator, power supply unit, and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the ozone system Equipment, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of WTP personnel.

.5 Do not route water piping directly above power supply units.

.6 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 meters above finished floor. Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 meters from the finished floor.

.7 The Contractor shall clean all piping, valving, and all other equipment installed by the Contractor, in accordance with the equipment Manufacturers' written recommendations and directions and the applicable codes, standards, and regulations, prior to start up.

3.2 Ozone generators

.1 The Supply Contractor will provide printed instructions for installation of all equipment except dielectrics to the Contractor.

.2 Installation of the dielectrics will be performed by the Supply Contractor. Proper installation of the dielectrics is to be completed prior to issuance of the Certification of Satisfactory Installation. The Contractor shall coordinate timing of installation of the dielectrics with the Supply Contractor.

3.3 Cooling Water System

.1 The Contractor shall supply and install all piping between the cooling water system skids and the generators and power supply unit skids, between the open loop cooling water pumps, the open-loop water source and the cooling water skid, and between the cooling water system skids and the open loop cooling water return, as outlined in the Contract Drawings.

.2 The Contractor shall supply and install the open loop cooling water pumps and accessories as per the Contract Drawings, and as specified in Section 11501 – Vertical In-line Centrifugal Pumps.

3.4 Off-gas Destruct System

.1 The Contractor shall supply and install all external gas piping between the contactors and the demisters; the demisters and destruct skid; and piping downstream of the destruct system skid, as outlined in the Contract Drawings.

.2 The Contractor shall Install PSVs in the ozone contactor tank's ceiling slab as per Contract Drawings.

3.5 Nitrogen Boost Skid

.1 The Contractor shall supply and install all external gas piping between the Air Receiver and the Gaseous Oxygen (GOX) feed to the generators as per Contract Drawings.

3.6 Ozone Dissolution

.1 The Contractor shall supply and install all external gas piping between the ozone generators and the diffuser flow control manifold, and from the flow control manifold to the diffuser pipe manifold within the contactors, as outlined in the Contract Drawings.

3.7 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 01, including but not limited to Section 01650 – Equipment Installation, Section 01664 – Training, and Section 01670 – Commissioning.

END OF SECTION

LARGE BUTTERFLY VALVE INSTALLATION

1. RGENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 731-2005.

.2 The Contractor shall comply with all Division 1 requirements.

.3 The Contractor shall supply and install all components, wiring, connections, accessories, etc. as specified in the Contract Documents required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the large butterfly valves as set forth in Bid Opportunity No. 731-2005. The large butterfly valves including, but not limited to the equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the Work necessary by the Contractor to install, the large butterfly valves described in Bid Opportunity No. 731-2005.

.2 Unloading and installation of the furnished valves and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor.

.3 All external conduit and wiring required for the actuators and other ancillaries, unless otherwise specified, shall be supplied and installed by Division 16.

.4 The Contractor shall touch-up any shipping or installation damage to the finish, following installation.

.5 Performance Verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and supplying valves and actuators as specified in Bid Opportunity No. 731-2005, and for coordination all major components. This includes, but is not limited to, proper sizing, testing, and performance of all components.

.2 Supply Contractor to provide services for valve and actuator Performance Testing and services including installation assistance, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Install the valves and actuators to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 ANSI

.2 ASME

.3 ASTM

.4 Canadian Electrical Code

.5 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.6 AWWA

.7 AWS

.8 CSA

.9 ESA

.10 ISA

.11 NFPA

.12 EEMAC

.13 Local codes, by-laws, and regulations

.14 NEMA

.2 Specific regulations for each package are listed within the individual Specifications.

1.5 Submittals

.1 Complete all documentation in accordance with Section 01210 – City Supplied Equipment.

2. PRODUCTS

2.1 Electrical

.2 All electrical Work shall comply with requirements of Divisions 16 and 17.

2.2 Mechanical

.1 All mechanical Work shall comply with requirements of Divisions 9, 11, and 15.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.1 The valves and actuators shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.2 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 – City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.3 All equipment shall be received by the Contractor at the City Warehouse, in accordance with the Project Master Schedule. The Contract Administrator shall arrange for a representative of the Supply Contractor to be present at the City Warehouse during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide On-Site instruction for unloading of the valves and actuators and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the valves, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.4 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of WTP personnel.

.5 Where possible, locate process valves, instrumentation, and other control devices that require regular operation and/or maintenance at an elevation 1.8 m above finished floor (unless otherwise specified). Instruments with local indication that are located above 1.8 m from floors shall be provided with remote indicators mounted not more than 1.2 m from the finished floor.

.6 The Supply Contractor will provide printed instructions for installation of all valves to the Contractor.

3.2 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 1, including but not limited to Section 01210 – City Supplied Equipment, Section 01664 – Training, and Section 01670 – Commissioning and as outlined in Bid Opportunity No. 731-2005.

END OF SECTION

SLUICE GATE AND FLAP GATE INSTALLATION

1. GENERAL

1.1 General Requirements

.1 The Contractor shall provide all services to coordinate installation of all City Supplied Equipment supplied pursuant to Bid Opportunity No. 561-2005.

.2 The Contractor shall comply with all Division 1 requirements.

.3 The Contractor shall supply and install all components, wiring, connections, accessories, etc. as specified in the Contract Documents required to complete the installation of the City Supplied Equipment.

.4 All equipment furnished by the Supply Contractor will conform to the requirements for the Supply of Water Treatment Plant Sluice Gates as set forth in Bid Opportunity No. 561-2005. All equipment specified, shall be the end products of one Manufacturer to achieve standardization for appearance, operation, maintenance, spare parts, and Manufacturer's services.

1.2 Work by Contractor

.1 This Section covers the Work necessary by the Contractor to install, the gates described in Bid Opportunity No. 561-2005.

.2 Unloading and installation of the furnished gates and accessories at the Site, with the exception of items to be assembled within the scope of the Supply Contractor.

.3 All external conduit and wiring required for the actuators and other ancilliaries, as per Division 16.

.4 The Contractor shall touch-up any shipping or installation damage to the finish, following installation.

.5 Performance verification assistance.

1.3 Work by Supply Contractor

.1 The Supply Contractor is responsible for designing and furnishing gate and actuators and for coordination all major components. This includes, but is not limited to, proper sizing, testing, and performance of all components.

.2 Supply Contractor to provide services for gate and actuator Performance Testing and services including installation support, inspection, equipment testing, start-up, installation certification and training of City personnel.

1.4 References

.1 Install the gate and actuators to conform to the latest editions or revisions in effect at the time of the bid submission of the applicable, codes, standards, and regulations from the following regulating bodies:

.1 ANSI

.2 ASME

.3 ASTM

.4 AWWA

.5 Canadian Electrical Code

.6 IEEE: 519 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters.

.7 AWWA

.8 AWS

.9 CSA

.10 ESA

.11 ISA

.12 NFPA

.13 EEMAC

.14 Local codes, by-laws, and regulations

.15 NEMA

.2 Specific regulations for each package are listed within the individual Specifications.

1.5 Submittals

.1 Complete all documentation in accordance with Section 01210 – City Supplied Equipment.

2. PRODUCTS

2.1 Electrical

.1 All electrical work shall comply with requirements of Divisions 16 and 17.

2.2 Mechanical

.1 All mechanical work shall comply with requirements of Divisions 9, 11, and 15.

3. EXECUTION

3.1 Delivery of Equipment and Installation

.2 The gate and actuators shall be installed by the Contractor in accordance with the Supply Contractor's written recommendations and directions. The Supply Contractor may be present to oversee installation of the equipment by the Contractor.

.3 Contractor shall coordinate delivery, handling, storage and installation of equipment as per Section 01210 – City Supplied Equipment and Section 01650 – Equipment Installation, and complete all required Forms with the Supply Contractor and Contract Administrator.

.4 All equipment shill be received, uncrated, and installed by the Contractor at the City warehouse, in accordance with the Project Master Schedule. The Contract Administrator shall arrange for a representative of the Supply Contractor to be present at the City warehouse during the unloading to inspect the delivered equipment and witness the unloading process. The Supply Contractor will provide On-Site instruction for unloading of the gate and actuators and all other related equipment. The Supply Contractor will notify the Contractor of any special items necessary for unloading any of the gate, such as special slings, spreader beams, etc. Supplying these special items for unloading shall be the responsibility of the Contractor.

.5 Ensure all operators are installed at a height and orientation as specified on the Drawings.

.6 The Supply Contractor will provide printed instructions for installation of all gates to the Contractor.

.7 Gates are to be installed as water tight structures as per Supply Contractor instructions and requirements.

3.2 Performance Testing

.1 The Contractor shall coordinate all demonstration, functional running, and performance testing requirements with the Contract Administrator and Supply Contractor as per Division 1, including but not limited to Section 01210 – City Supplied Equipment, Section 01664 – Training, and Section 01670 – Commissioning Plan and as outlined in Bid Opportunity No. 561-2005.

END OF SECTION

MIXERS AND FLOCCULATORS, GENERAL

1. GENERAL

1.1 Description

.1 The Contractor shall provide mixers, flocculators and appurtenances, complete and operable, in accordance with the Contract Documents.

.2 The requirements of Section 11000 - Equipment General Provisions, apply to the Work of this Section.

.3 This Section applies to all mixers and flocculators in the Contract Documents, unless indicated otherwise.

1.2 Reference Specifications, Codes, and Standards

.1 American National Standard Institute (ANSI)/National Fire Protection Association (NFPA) 70 - National Electric Code.

.2 ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.

.3 ANSI B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

.4 ANSI/American Society of Mechanical Engineers (ASME) B31.1 - Power Piping.

.5 ANSI/ASME B73.1 - Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process.

.6 ANSI/Institute of Electrical and Electronic Engineers (IEEE) 112 - Test Procedure for Polyphase Induction Motors and Generators.

.7 ANSI/IEEE 115 - Test Procedure for Synchronous Machines.

.8 American Society for Testing and Materials (ASTM) A 48 - Gray Iron Castings.

.9 ASTM A 470 - Vacuum-Treated Carbon and Alloy Forgings for Turbine Rotors and Shafts.

.10 ASTM A 536 - Ductile Iron Castings.

.11 ASTM B 62 - Composition Bronze or Ounce Metal Castings.

.12 Latest Edition Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps.

1.3 Contractor Submittals

.1 Shop Drawings

.1 Equipment name, identification number, and Specification number.

.2 Performance data.

.3 The Contractor shall require the Manufacturer to indicate the limits recommended for stable operation between which the mixers, and flocculators may be operated without surge, cavitation, or vibration. The stable operating range shall be as wide as possible based on actual hydraulic and mechanical tests.

.4 Equipment detailed description and Specification.

.5 Electrical data including control and wiring diagrams.

.6 Assembly and Installation Drawings including shaft size, seal, coupling, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

.7 Removal and disassembly instructions

.8 Drive and motor data in accordance with Section 11301 – Process Motors.

.2 Certification: The Contractor shall obtain written certification from the Manufacturer, addressed to the City, stating that the equipment will efficiently and thoroughly perform the required functions and that the Manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, drives, controls, and services required for proper installation and operation of the completely assembled and installed units. The Contractor shall submit completed forms 102 and 103 to the Contract Administrator.

.3 Operation and Maintenance (O&M) Manuals: Prior to start-up, furnish complete O&M manuals in accordance with Section 01300 - Submittals. Printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary, shall be furnished in duplicate with each unit or set of identical units. Instructions for field procedures for erection, adjustments, inspection, and testing shall be provided prior to installation of the equipment.

1.4 Manufacturer's Representative

.1 Erection and Start-up Assistance: Service and instruction assistance by the Manufacturer's Representative shall be as per Section 01650 – Equipment Installation.

.2 Instruction of City's Personnel: Refer to Section 01650 – Equipment Installation**.** The Contractor shall furnish the services of a factory service representative to instruct the City's personnel in the O&M of the equipment.

1.5 Warranties

.1 The Contractor shall also furnish the Manufacturer's warranties as published in its literature and as specified.

2. PRODUCTS

2.1 General

.1 Equipment provided under this Section shall be new, current models of reputable Manufacturers specializing in such products; and having had previous experience in such manufacture.

.2 Where two (2) or more units of the same type and/or size of equipment are required, such units shall all be produced by the same Manufacturer.

2.2 Materials

.1 Materials shall be suitable for the intended application; material not specifically called for shall be high-grade, standard commercial quality, free from all defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended. Unless otherwise indicated, materials shall conform to the following requirements:

.1 Cast iron casings shall be of close-grained grey cast iron, conforming to ASTM A 48, or equal.

.2 Bronze impellers shall conform to ASTM B 62.

.3 Stainless steel shafts shall be of Type 300 or 400 Series, as best suited for the purpose. Miscellaneous stainless steel parts shall be of Type 316L.

2.3 Appurtenances

.1 Nameplates: Each piece of equipment shall be equipped with a stainless steel nameplate indicating rated performance, size, speed, and Manufacturer's name and model number.

.2 Solenoid Valves: The Manufacturer shall provide any solenoid valves on water or oil lubrication lines and on all cooling water lines. Solenoid valve electrical rating shall be compatible with the motor control voltage and shall be provided complete with all necessary conduit and wiring installation from control panel to solenoid.

.3 Variable Frequency Drives: Variable speed drives, speed control equipment, and accessories shall be provided in accordance with Section 16815 - Variable Frequency Drives.

.4 Motors: Motors shall comply with Section 11301 – Process Motors.

.5 Flanges: Equipment flanges shall conform to ANSI B16.1 or B16.5 dimensions.

.6 Lubrication: Equipment shafts, bearings, gears, and other moving parts shall be grease, oil, or self lubricated. All lubricating points shall be filled with the recommended lubricants.

.7 Equipment Seals: Seals on equipment shafts shall be the Manufacturer's best quality mechanical seals, as best suited for each individual application. Where necessary, such seals shall be oil lubricated or water-flushed.

3. EXECUTION

3.1 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance are identified in Section 11210 – Vertical Shaft Flocculators.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

3.2 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.3 Equipment Performance Testing

.1 The Manufacturer’s Representative shall ensure that each mixer, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.4 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

END OF SECTION

VERTICAL SHAFT FLOCCULATORS

1. GENERAL

1.1 Description

.1 This Section applies to the supply, verification of the on-Site equipment installation, testing, performance verification, and training for vertical-shaft flocculating assemblies and related appurtenances, complete and operable, in accordance with the Contract Documents.

.2 The requirements of Section 11000 - Equipment General Provisions, apply to this Section.

1.2 Submittals

.1 Shop Drawings: Submit in accordance with Section 01300 – Submittals.

.2 Operating and Maintenance (O&M) Data: Provide for incorporation in O&M Manual as specified in Section 01730 – Operation and Maintenance Manuals.

.3 Calculations: Submit the Manufacturer's calculations, certified by a Professional Engineer registered in the Province of Manitoba, for the gear rating and bearing life of the unit.

1.3 Warranties

.1 The Contractor shall also furnish the Manufacturer's warranties as published in its literature and as specified.

2. PRODUCTS

2.1 General

.1 Design: All flocculators shall be hydrofoil-type impeller units of the same design and manufacture. All parts shall be designed and proportioned for ample strength, stability, and stiffness for the intended purpose. Ample space and access shall be provided for inspection, repairs, lubrication, and adjustment. Each flocculator and drive assembly shall be designed for twenty-four (24) hour-a-day continuous service and shall be built in accordance with the current American Gear Manufacturer’s Association (AGMA) Standards. Ensure flocculator shaft and mixer design incorporates lateral deflection and torque forces for intended application.

.2 To ensure design integration and system responsibility, the flocculator gear reducer must be designed and supplied by one Manufacturer. The flocculator Manufacturer shall be responsible for the manufacture, delivery, and satisfactory operation of the complete system that includes speed reducers, pedestals, drives, shafts, blades, seals, bearings and all other equipment specified herein.

.3 Motors: All motors shall be of the heavy-duty, high efficiency, totally enclosed fan-cooled (TEFC) type, in accordance with Section 11301 – Process Motors. All motors shall be 600

V, three (3)-phase, 60 Hz. If required, the motor shall be started with a variable frequency drive (VFD) in accordance with Section 16811 – Motor Starters to 600V and Section 16815 – Variable Frequency Drives, where they apply. The flocculator motors shall be in accordance with National Electrical Manufacturer's Association (NEMA) MG1, part thirty (30) and thirty one (31).

.4 Anchorage: The Contractor shall provide equipment Manufacturer recommended stainless steel anchor bolts, nuts, and washers. Templates necessary for setting the equipment shall be incidental to the supply.

.5 Factory Test: Each flocculation unit shall be subjected to a full size scale factory test by the Manufacturer of the units, in the exact field dimensions plus or minus 300 mm. The test shall be witnessed by one (1) representative of the Contract Administrator. Each test flocculator shall be operated to demonstrate its ability to meet the specified mixing requirements and velocity gradient "G" values. The flocculator shall operate smoothly, without overloading, jamming, or excessive noise or vibration during normal speed.

.6 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid.

.7 The supply of vertical shaft flocculators under this Section shall come from a single Manufacturer.

2.2 Flocculator Units

.1 The flocculator mixer units shall be properly sized to deliver the appropriate energy input for effective flocculation. The flocculator mixers shall provide the specified range of velocity gradient over the specified range of design flows and water temperatures. Supply of tank baffling to increase mixing efficiency will be permitted.

.2 The reducer housing and mounting base shall be designed to resist all loads applied to the drive. Suitable provision shall be made for the adjustment and alignment of the various components when correct alignment is achieved. The housing shall be fitted with lifting eyebolts or lugs for ease and safety when installing or removing the flocculator.

.3 The impellers shall be high efficiency, low shear, hydraulically balanced and accurately keyed to the shaft and fixed in an axial position by shaft sleeve nuts or other positive positioning devices.

.4 The impeller shaft shall be of Stainless Steel construction with adequate diameter to withstand the torsion loads and bending moments to which it may be subjected. It shall also be designed to reduce detrimental vibration stresses to a minimum. Shaft surfaces shall be accurately ground and polished. Shaft shall be constructed in two pieces complete with rigid

couplings to facilitate removal of the flocculator mixer with the headroom available in the building. The coupling flanges shall be rabbetted and keyed to assure positive alignment.

.5 The flocculator drives that have lower grease lubricated bearings, or rely on lip seals for the containment of lubrication shall have split-type mechanical shaft seals. Sealing faces shall be carbon/silicon carbide or as approved. Drives specifically designed for open-tank flocculator service that do not incorporate grease lubricated lower bearings or lip seals to contain lubrication are not required to include mechanical shaft seals.

.6 The flocculator mixer unit's maximum speed shall be less than 60% of the first critical speed. The use of stabilising rings or fins shall not influence this limitation.

.7 The motor and drive for the flocculator mixer units shall be suitable for a vertical mounted, top entry agitator, bolted on concrete floor above flocculation chamber.

.8 The gear drive's minimum AGMA service factor, based upon motor nameplate horsepower, shall be 1.50.

.9 All bearings shall have minimum L10 life of 100,000 hours.

.10 The drive shall be provided with a dip stick and/or sight glass to observe oil level. Lubrication of the reducer gear drive shall be by means of an efficient oil splash mechanism. The drive shall have an effective drywell feature to eliminate oil leakage down the output shaft.

.11 No oil or grease shall be exposed over the water in the Flocculation Tanks. Drip containment pans shall be provided under all gear mechanisms. A drive stand shall be provided for each flocculator mixer to facilitate drive maintenance and changing of the drive's oil.

.12 Output shaft bearings can be grease (food-grade white) lubricated, including a high quality seal to retain grease.

.13 Provide oil gauges, grease cups, oil cups or grease gun fittings at all points requiring lubrication. Extend all fittings as required to be fully accessible without requiring any disassembly or removal of guards.

.14 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

.15 Nameplates: Each piece of equipment shall be equipped with a stainless steel nameplate indicating rated performance, size, speed, and Manufacturer's name and model number.

2.3 Tools and Spare Parts

.1 Tools: Special tools necessary for maintenance and repair of the equipment and one (1) pressure grease gun for each type of grease required for the flocculators, and motors shall be furnished as a part of the Work hereunder; such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

.2 Spare Parts: Furnish the following, in addition to the requirements of the individual mixer and flocculator Sections. Package the spare parts in a labelled box as required above for tools.

.1 Seals, packing, gaskets, nuts, bolts, washers, and wear rings, as well as a spare set of bearings.

.2 Other parts subject to wear.

.3 Parts specific to mixers:

.1 One (1) impeller.

.2 One (1) gearbox.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation shall be by the Contractor in accordance with the Manufacturer's printed installation instructions.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901 - Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each piece of equipment.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Operating Temperatures: Monitor bearing areas on flocculator and motor for abnormally high temperatures.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each flocculator, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Filter Aid Flocculators: MXR-C701A, MXR-C702A.

.2 Thickened Sludge Equalization Tank Flocculator: MXR-O710C, MXR-O720C

.3 Polymer mixer in Flocculation Tank: MXR-R001C

END OF SECTION

SUPPLEMENT 1 – FILTER AID FLOCCULATORS

PARAMETER	VALUE
Tag No. (s)	MXR-C701A, MXR-C702A
Maximum Feed Flow (ML/d)	203.5
Velocity Gradient:	200 s-1 @ 0.5°C
Viscosity (cp)	1.00
Mixing System	Mechanical, vertical
Motor Suitable for Variable Speed Drive	No
Flocculation impeller	Stainless Steel - Hydrofoil Design
Materials - Shaft	Stainless Steel
Materials - All Wet Areas	Stainless Steel
Materials - Casing	Cast Iron, Epoxy Coated, colour to match WTP color scheme
Direction of Flow	Down flow
Average Side Water Depth	Refer to Drawings
Cell Width	Refer to Drawings
Cell Length	Refer to Drawings
Flocculation cell volume ($m^{3)}$	19.3
Mounting Elevation (m)	245.00
Tank Bottom Elevation (m)	240.74
Water Temperature (^{o}C)	0.5 to 25
Mech Floc Zone HRT (s)	8
Minimum Motor Size per Unit (kW)	2.2
Acceptable Manufacturers	SPX Process Equipment/Lightnin Operation Flowserve Approved equal

N/A – not applicable.

SUPPLEMENT 2 – THICKENED SLUDGE EQUALIZATION TANK FLOCCULATORS

PARAMETER	VALUE
Tag No. (s)	MXR-O710C, MXR-O720C
Design Inflow - Min, Avg, Max (L/s)	1.45, 8.00, 23.10
Operating Depth – Min, Avg, Max (m)	1.4, 3.0, 5.0
Solids Concentration – Min, Avg, Max (%)	0.1, 1.5, 3.0
Velocity Gradient:	50 s-1 @ 0.5°C, 200 s-1 @ 10°C, 300 s-1 @ 25°C
Turndown Ratio	6:1
Viscosity (cp)	100
Motor Suitable for Variable Speed Drive	Yes
Mixing System	Mechanical, vertical
Flocculation impeller	Stainless Steel – Two Piece Bolted Design
Materials - Shaft	Stainless Steel
Materials - All Wet Areas	Stainless Steel
Materials - Casing	Cast Iron, Epoxy Coated, colour to match WTP color scheme
Cell Height (m)	9.16 (includes 400 mm roof slab)
Cell Width (m)	1.86
Cell Length (m)	3.0
Mounting Elevation (m)	239.41
Tank Bottom Elevation (m)	230.25
Water Temperature (^{o}C)	0.5 to 25
Minimum Motor Size per Unit (kW)	2.2
Acceptable Manufacturers	Hayward Gordon – Model 115A-115B SPX Process Equipment/Lightnin Operation – Model 504Q Approved equal

N/A – not applicable.

SUPPLEMENT 3 – POLYMER MIXER IN FLOCCULATION TANK

PARAMETER	VALUE
Tag No. (s)	MXR-R001C
Design Inflow - Min, Avg, Max (L/s)	30, 42.00, 42.00
Operating Depth – Min, Avg, Max (m)	0.7, 0.9, 1
Solids Concentration – Min, Avg, Max (%)	0.05, 0.3, 1
Velocity Gradient:	500 s-1, 750 s-1, 1000 s-1
Turndown Ratio	4:01, 5:01, 6:01
Viscosity (cp)	100
Motor Suitable for Variable Frequency Drive	Yes
Mixing System	Mechanical, vertical
Flocculation Impeller	Stainless Steel 316
Materials – Shaft	Stainless Steel 316
Materials – All Wet Areas	Stainless Steel 316
Materials – Casing	Cast Iron, epoxy coated, colour to match plant colour scheme
Tank Height (m)	1.6 (includes 400 mm roof slab)
Tank Width (m)	2
Tank Length (m)	0.6
Mounting Elevation (m)	239.41
Tank Bottom Elevation (m)	237.81
Water Temperature (^{o}C)	0.5 to 25
Maximum Impeller Size (mm)	383
Minimum Motor Size per Unit (kW)	2.24
Accessories	Variable Frequency Drives, Stainless Steel 316 mounting flange complete with gasket and Stainless Steel 316 nuts and bolts
Design Standard	Hayward Gordon Ltd.
Acceptable Manufacturer	SPX Process Equipment/Lightnin Operation Hayward Gordon Ltd.

CHEMICAL STORAGE TANKS

1. GENERAL

1.1 General Requirements

.1 Conform to Division 1.

1.2 Intent of Section

.1 A general description of the equipment is given herein. It is intended that the Contractor provide all components of the systems described in order that the tanks perform in the manner intended.

.2 Supply and install one polyethylene storage tank as described herein for the sodium bisulphite chemical feed system.

.3 Supply and install two 316L stainless steel storages tank as described herein for the hydrogen peroxide chemical feed system.

1.3 Related Work Specified Elsewhere

.1 Section 15200-000 – Process Piping

1.4 Submittals

.1 Submit shop drawings in accordance with Division 1.

.2 Provide shop drawings for the tanks signed and sealed by a Professional Engineer registered in the Province of Manitoba.

.3 Shop drawings to include:

.1 Fitting layouts and details

.2 Where applicable, details of bag liners

.3 Sight level gauges.

2. PRODUCTS

2.1 Sodium Bisulphite Storage Tank

.1 The Sodium Bisulphite tank specified herein shall be cross linked high-density polyethylene construction (XLHDPE) with interior anti-oxidant resistant linear HDPE liner and integrally mounted flanged outlet (IMFO) and shall meet or exceed all requirements of ASTM D1998.

.2 Tanks shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.

.3 The XLHDPE tanks shall be constructed using the rotational molding process.

.4 Tanks shall be fabricated to the dimensions shown on the Drawings.

.5 Materials shall meet or exceed the following properties:

Parameter	ASTM Test	Requirement
Density	D1505	0.944-0.946 gm/cc
Environmental Stress, Cracking Resistance (F50)	D1693	1,000 hrs
Tensile Strength, Ultimate (2" min.)	D638	18,000-20,600 kPa
Elongation at Break (2" min.)	D638	400%
Vicat Softening Point	D1525	115 degrees C
Flexural Modulus	D790	690,000 kPa
Brittleness Temperature	D746	-90 degrees C
Heat Distortion Temp	D648	67 degrees C
Polyethlynene Notch Test (PENT)	F1473	>1,000 hours

.6 Tank Support and Restraint System

.1 Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.

.2 Provide hold down lugs, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of hold down lugs shall be calculated with the tank empty.

.3 Provide a neoprene spacer beneath the plastic tank to minimize the risk of an object piercing the bottom of the tank. Size the neoprene spacer to suite tank size.

.7 Fittings

.1 Provide all fittings for the tanks as shown on the drawings and as required for instrumentation.

.2 Provide fill line extension to inside of feed tank. Fill line extension to be 0.5 m in length.

.3 Fittings shall be PVC compressive type, with long shank, deep cut threaded with dual wide nut assembly.

.4 All flanged fittings shall be gasketed with materials compatible with the chemical service.

.5 Bolted fittings shall use Hastelloy C-2000 bolts and nuts with polyethylene-encapsulated heads and PVC external flanges.

.6 All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

.8 Accessories and Appurtenances

.1 All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.

.2 Gaskets:

.1 Material compatible with chemical service, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.

.2 Type: 6 mm thick, low torque, full face, ASME B16.1 dimensions.

.9 Pipe Supports:

.1 Pipe supports shall not be attached tank.

.10 Lifting Lugs: Provide suitably attached for all tanks weighing over 50 kg. Lifting lugs shall be molded into the tank wall. Bolted fittings shall be as specified herein.

.11 Anchor Bolts: Type 316L, stainless steel bolts, sized by fabricator. Bolts to be drilled in and secured in place with Hilti fasteners.

2.2 Hydrogen Peroxide Storage Tanks

.1 General

.1 Tank height provided in supplement No. 1 is from tank bottom to lowest point of tank roof.

.2 The tank design to comply with the requirements of the American Petroleum Institute (API) Standard 650, latest edition

.3 Tank materials of construction to be 316L stainless steel.

.4 The tank bottom to be double welded butt joints. The shell to bottom joints to be full penetration joints with reinforcing fillets. Shell horizontal and vertical joints to be full penetration welds.

.5 Minimum thickness of tank bottoms to be 12.5 mm.

.6 Corrosion allowance for tank and fitting materials to be 3.2 mm thickness.

.7 Provide all fittings for the tanks as shown on the drawings and as required for instrumentation.

.8 609 mm diameter flanged tank access side manhole and cover, with gasket and fasteners. Centre line of tank access 900 mm above tank bottom.

.9 609 mm diameter flanged access manhole and cover on tank top, with gasket and fasteners.

.10 Access platform shall be provided to allow for access to top of tanks. Refer to drawings for details.

.11 Provide and pay for the services of an independent radiographic inspection agency to carry out inspection. Submit reports to the Contract Administrator.

.12 Provide 100% radiography of tank bottom welds, vertical shell welds and T-joints in the shell. For horizontal shell welds, provide spot radiography using 432 mm film length, minimum 2 per each horizontal weld.

.13 Repair or replace and re-radiograph all unacceptable welds at the Contractor's cost.

.14 Affix labels clearly identifying chemical and tank capacity as indicated in supplement No. 2.

.15 A tank level readout shall be provided for each tank at the hydrogen peroxide truck fill connection. The tank level readout shall be based on each tank's ultrasonic transducer.

.2 Sight Level Gauges:

.1 Provide sight level gauges for each storage tank of clear tube materials suitable for the chemicals contained in tank c/w shutoff valves and vent.

.2 Provide mounting brackets on the tanks to mount the sight gauges.

.3 Provide a scale graduated in litres and percent mounted on the clear tube.

.4 Sight gauge to be suitable for full height of tank.

.5 Liquid level to be readily visible from a distance of 5 m.

.6 For hydrogen peroxide, provide glass or PFA sight level gauges with shielding to protect from damage but allow full height visibility of fluid in the tube.

.3 Level Transmitters

.1 Provide liquid level control sensors to detect hydrogen peroxide levels in each storage tank.

.2 Liquid level sensors shall consist of ultrasonic transducer

.3 Provide two (2) level indicating display readouts for each storage tank. For each storage tank, one level display shall be located inside the Peroxide Storage and Feed Room and the other shall be located outside at the hydrogen peroxide truck fill station.

.4 Outdoor level display units shall be designed and rated for outdoor exposure.

.4 Temperature Transmitters

.1 Provide temperatures sensors to detect hydrogen peroxide temperature in each storage tank.

.2 Provide temperature indicating display readouts for each storage tank.

2.3 Hydrogen Peroxide Storage Tank Passivation

.1 All hydrogen Peroxide feed tanks shall be pickled and passivated before acceptance by the City for filling with chemical.

.2 All Hydrogen Peroxide storage tank pickling and passivation shall be in accordance with Section 15200-000 – Process Piping.

2.4 Chemical Storage Tank Identification Signs

.1 For each new chemical storage tank, provide a Bulk Storage Tank Design Information Sign and an NFPA Chemical Storage Tank Sign. Each to be a minimum size of 250 x 350 mm, manufactured of Plastic, Aluminum or Stainless Steel plate. Mount signs on an external wall of each chemical storage tank in an accessible location, approximately 1600 mm above floor.

.2 Diagram and lettering to be permanently etched into sign and clearly legible from a minimum distance of 2.0 m.

.3 Details of each Bulk Storage Tank Design Information Sign is to be determined by the Contractor in conjunction with tank Manufacturer and Systems Integrator following successful Site Performance Verification and testing.

.4 Contractor to obtain NFPA, MSDS information and Chemical Abstract Service Registry Numbers (CAS) for Chemical Storage Tank Signs from the City's chemical suppliers.

.5 Refer to sample identification signs contained within the supplements at the end of this Section. Submit product sample and final artwork for review and approval by Contract Administrator prior to fabrication and installation.

3. EXECUTION

3.1 Tank Installation

.1 Before installation of tanks, complete the tank bases, including the chemical resistant coating on the concrete tank base.

3.2 Tank Hydrostatic Testing

.1 Fill the tanks with potable water to the underside of the roof and leave full for a period of 48 hours. Check for leakage and monitor levels. Repair and re-test if any leaks are found until leak tight. Bear all costs for repair and re-testing.

.2 Test the sight level gauges in conjunction with the tanks.

.3 Water for testing will be available from the City. The Contractor to provide all equipment and piping necessary to fill and drain the tanks. Dispose of the water in a manner approved by the Contract Administrator.

.4 Clean and dry all tank, pickle and passivate before acceptance by the City for filling with chemical.

3.3 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance for each tank supplied are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	1	102
4	Assistance in Equipment Performance Testing	1	103
5	Operator and Maintenance Training	1	T1

3.4 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation**.**

3.5 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.6 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.7 Supplements

.1 Supplements listed below, follow "END OF SECTION" and are part of this Section. This includes the following:

.1 Data Sheets – Hydrogen Peroxide Storage Tanks: TK-C810A, TK-C820A.

.2 Data Sheets – Sodium Bisulphite Storage Tank: TK-C940

.3 Bulk Storage Tank Design Information Sign - Sample

.4 NFPA Chemical Storage Tank Sign - Sample

END OF SECTION

SUPPLEMENT 1 – HYDROGEN PEROXIDE STORAGE TANKS

PARAMETER	VALUE
Tag No. (s)	TK-C810A, TK-C820A
Tank Diameter (m)	1.625
Tank Height (m)	4.6
Tank Commodity	Hydrogen Peroxide
Commodity Concentration	35%
Commodity Specific Gravity	1.13
Tank Material	316L Stainless Steel
Acceptable Manufacturer	Westeel Approved equal

N/A – not applicable.

SUPPLEMENT 2 – SODIUM BISULPHITE STORAGE TANK

PARAMETER	VALUE
Tag No. (s)	TK-C940
Tank Diameter (m)	1.625
Tank Height (m)	2.0
Tank Commodity	Sodium Bisulphite
Commodity Concentration	38%
Commodity Specific Gravity	1.33
Tank Material	High-Density Polyethylene
Acceptable Manufacturer	Norwesco Equinox Tanks Approved equal.

N/A – not applicable.

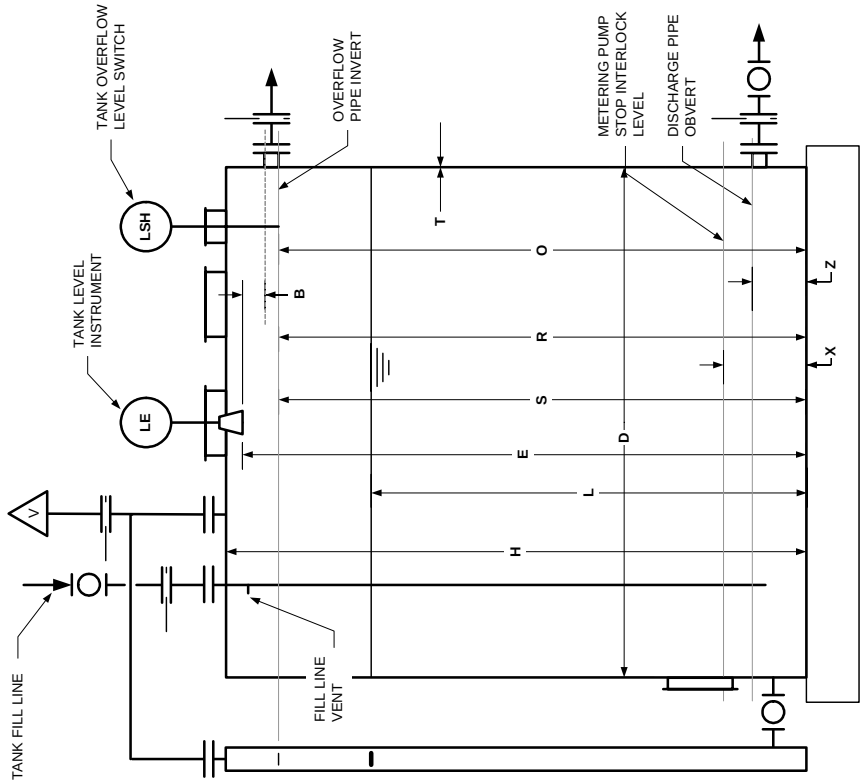
SUPPLEMENT 3 - BULK STORAGE TANK DESIGN INFORMATION SIGN (SAMPLE)

CHEMICAL NAME

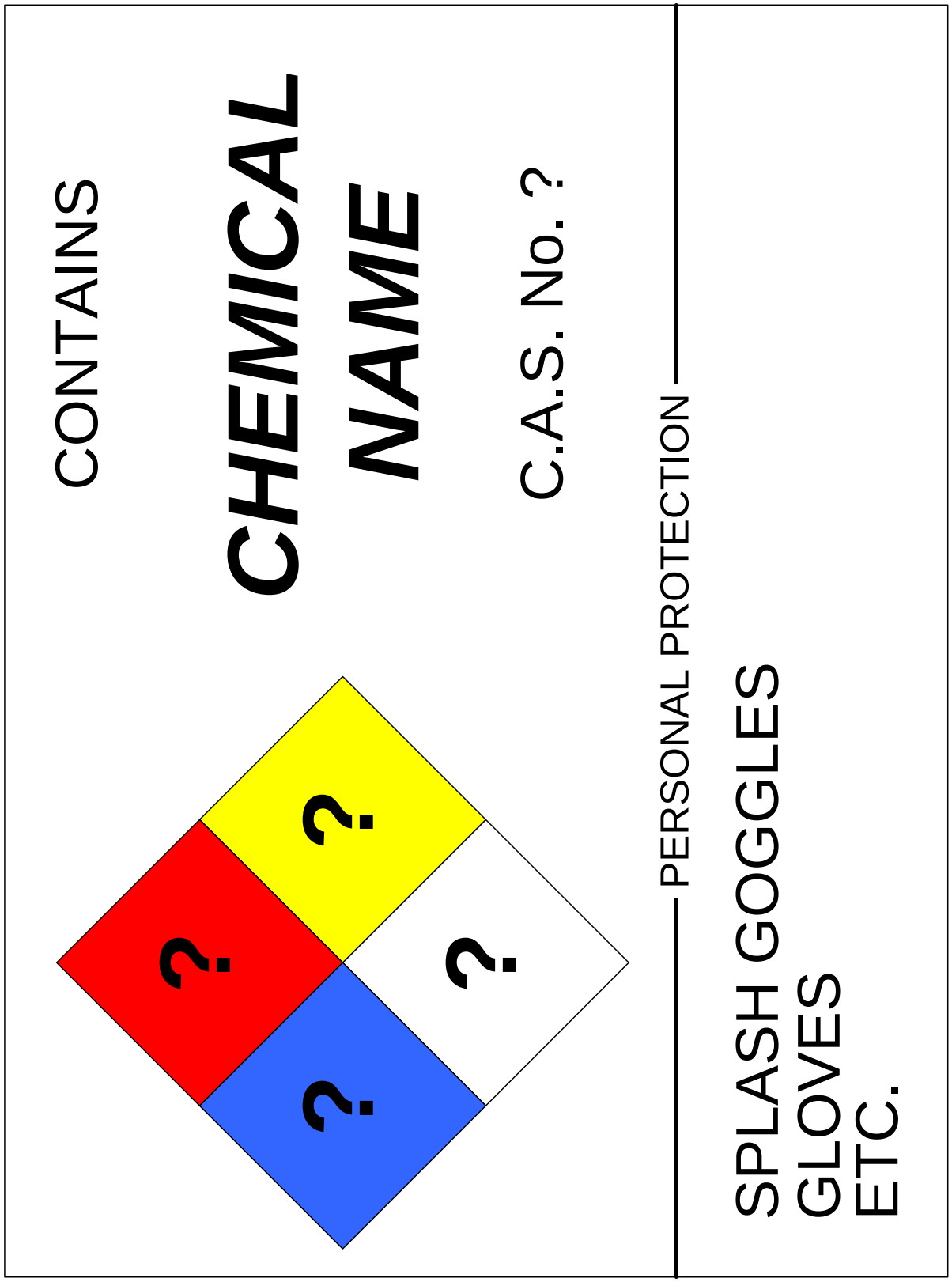
BULK STORAGE TANK No. X

MANUACTURED BY:	
DATE:	
SERIAL NUMBER:	
TANK MATERIAL:	
LINER MATERIAL:	
TAG ID:	

DIM	VALUE	DESCRIPTION
B	? mm	LEVEL INSTRUMENT BLANKING DISTANCE
D	? mm	TANK INTERNAL DIAMETER
E	? mm	LEVEL INST. EMPTY DISTANCE
H	? mm	TANK HEIGHT
L	? mm	LEVEL INSTRUMENT OUTPUT (0-100%)
S	? mm	LEVEL INSTRUMENT SPAN (100%)
O	? mm	OVERFLOW SWITCH HEIGHT
T	? mm	TANK WALL THICKNESS
R	? mm	TANK OVERFLOW PIPE INVERT
X	? mm	METERING PUMP STOP INTERLOCK
Z	? mm	TANK EQUALIZATION PIPE OBVERT
V_U	? L	USABLE TANK VOLUME: ? ·(S-Z)·D²/4
V_T	? L	MAXIMUM TANK VOLUME: ? ·H·D²/4



SUPPLEMENT 4 - NFPA CHEMICAL STORAGE TANK SIGN (SAMPLE)



PROCESS PUMP GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

.1 This Section specifies the general requirements for the supply of all pumps required for this Work.

1.2 Definitions

.1 The terms in the Specification generally comply with the definitions of the Hydraulic Institute.

.2 Definitions:

.1 Pump Bowl Efficiency: Pump efficiency shall be calculated as the pump delivered hydraulic power divided by the mechanical brake horsepower at the inlet shaft of the pump. It shall take full account of mechanical losses. Since this is difficult to measure in the field, it will be calculated based on the Overall Efficiency multiplied by the Electrical Efficiency of the Motor.

.2 Overall Efficiency: Pump and Motor overall efficiency shall be calculated as the pump delivered hydraulic power divided by the electrical power supplied to the motor. It shall take full account of mechanical and electrical losses.

.3 Electrical Efficiency: Motor efficiency shall be calculated as the motor delivered mechanical brake horsepower divided by the electrical power supplied to the motor. It shall take full account of mechanical and electrical losses and will be based on the published guaranteed efficiency of the motor.

.4 Performance curve: The performance curve is a graph of the flow delivered (L/s; x-axis) in relation to the discharge head (metres; y-axis). It generally denotes efficiencies as isopleths and may include net positive suction head (NPSH) requirements as a function of the flow.

.5 Best Efficiency Point (BEP): The BEP is the point in the pump performance curve where the pump operates at its highest pump efficiency.

.6 Rating Point: The pump rating point is the combination of discharge head and flow which the pump must satisfy. It typically is determined on the basis of all duty pumps (one or more, depending on the service) operating simultaneously against the worst system conditions (typically maximum headloss, minimum suction head, maximum discharge head, etc.). This condition is listed in the detailed pump Specification and must be satisfied by the pump supplied.

.7 Low Head Point: The low head point is the combination of head and flow which corresponds to the least head the pump might operate against. It is determined on the basis of only one (1) duty pump operating against the system conditions which would

produce the least discharge pressure (typically minimum headloss, maximum suction head, minimum discharge head, etc.). The minimum system head is shown or described for each pump. The Manufacturer must ensure that the pump can operate satisfactorily, without cavitation in the pump casing or over-stressing of the motor, at the intersection of the pump curve and the minimum head curve, or low head point.

.8 Low Speed Point: The minimum flow and head conditions against which a variable speed pump is expected to operate.

.9 NPSH: The total pressure (atmospheric) at the pump suction. The available NPSH is the pressure available at the pump suction and is a function of Site atmospheric pressure and suction piping losses. Required NPSH is the pressure required at the pump suction to ensure cavitation due to water column separation does not occur. Required NPSH shall be measured at the pump inlet connection whether that be at the casing or at the face of a suction reducer/elbow supplied as an integral part of the pump.

1.3 Submissions

.1 Shop Drawings: Submit in accordance with Section 01300 and 11000. For all pump Shop Drawings in addition to the requirements of Section 11000, include the following specific details:

.1 Performance curve for the pumping unit(s) superimposed on the system curve for the particular pumping application. With the performance curve, include efficiency isopleths and NPSH required (NPSHR) variation with flow. Where required in the specific pump Sections, the performance curve should be certified in accordance with Hydraulic Institute Standards.

.2 Motor operating data, including motor and insulation ratings, start-up and operating current ratings, operating voltage and amperage tolerances, description of construction complete with illustrative Drawings, and any other pertinent information.

.3 List of materials of construction, detailing the component parts of the pump(s), their materials of construction, and reference Specifications for those materials.

.4 Required ancillary services including but not limited to electrical, seal water, and drains. The sizes, ratings, and any other pertinent information related to these services.

.5 Installation instructions indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services (electrical, seal water, drains, etc.).

.6 Start-up instructions including lubricant requirements, electrical requirements, etc.

.2 Operating and Maintenance (O&M) Data: Provide for incorporation in O&M Manual as specified in Section 01730. Include the following:

.1 Complete description of operation.

.2 General arrangement and detailed Drawings.

.3 Wiring diagrams for power and control schematics.

.4 Parts catalogues with complete list of repair and replacement parts with Section Drawings, illustrating the connections and the part Manufacturer's identifying numbers.

1.4 Delivery and Storage by Manufacturer's Representative

.1 Prior to delivery, ensure that the Certificate of Readiness to Install (Form 101) is completed to ensure that the Contractor is ready to receive the specified equipment.

.2 Ship pre-assembled to the degree that is possible. Inform Contractor of any Site assembly requirements.

.3 Securely fasten heavy wood blanks to the pump flanges. Use blanks that are larger diameter than the flange. Protect machined surfaces against rusting. Protect threaded connections with threaded plugs or caps. Protect open, plain pipe ends with caps.

.4 Where pumps are to be stored on-Site for any period of time exceeding one (1) week, ensure there is no uneven wear or distortion of pump component parts.

.5 Identify any special storage requirements.

1.5 Coordination

.1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

2. PRODUCTS

2.1 Pump Performance Requirements

.1 Supply pumps that are suitable for continuous duty.

.2 Select impellers for fixed speed pumps that permit operation at an efficiency of within 5% of the efficiency at the BEP.

.3 For variable speed pumps, select pump speed and impeller diameter which allow operation from the Rating Point to the Low Speed Point at efficiencies within 10% of efficiency at the BEP.

.4 Ensure that motors are sufficiently sized to drive pumps at a maximum speed when the head is specified for the low head point.

.5 Supply pumps capable of operating at 30% of the flow at the rated capacity without exceeding the motor horsepower and capable of operating at any point on its characteristic

curve, to where that curve intersects the low head point, without exceeding motor power rating.

2.2 Pressure Sensing

.1 Supply a means of measuring inlet and outlet pressure with each pump, except as noted.

.2 For submersible pumps, supply only one (1) gauge for mounting on the discharge of the pump on a weldolet installed outside, but within 2 m of the wet well.

.3 Gauges

.1 Supply gauges that are 100 mm diameter, 13 mm bottom connection, complete with shut off cock with stainless steel movement and Bourdon tube.

.2 Use metric units of measurement (kPa or Pa), clearly indicated on the face of the gauge.

.3 Calibrate the gauges to read pressure ranges approximately as follows:

	Actual Pressure	**Gauge Pressure Range**
Suction	-50 to 50 kPa	-50 to 350 kPa
	50 to 200 kPa	0 to 350 kPa
	200 to 700 kPa	0 to 1000 kPa
Discharge	50 to 350 kPa	0 to 700 kPa
	350 to 700 kPa	0 to 1000 kPa
	700 to 1500 kpa	0 to 2000 kPa

.4 Acceptable Manufacturers: Ashcroft, H.O. Trerice.

.4 Pressure Sensors

.1 Supply annular ring, flow through type pressure sensors, with stainless steel body, a sensing element compatible with the corrosive and abrasive nature of the fluid being measured, 25 mm diameter.

.2 Acceptable Products: Red Valve Series 42 or Robbins and Myers RKL Series W.

.3 Provide stainless steel nipples extending to a tee from the pressure sensor. Mount the gauge on one leg of the tee. If a pressure indicator/transmitter/switch is shown on the Drawings, mount on the other side of the tee. Otherwise, plug the tee.

.4 Supply annular type pressure sensors with their initial fill of fluid.

2.3 Pump Seals

.1 Provide double mechanical seals, unless otherwise noted in the Specifications of the particular pump.

.2 Single mechanical seals can be used only where noted in the Specifications of the particular pump.

.3 Double mechanical seals are located adjacent to one another, with a cooling/flushing water filled space between. They are supplied as a single package.

.4 Provide non-destructive, self aligning seals of the stationary design which require no wearing sleeve for the shaft.

.5 Materials of construction:

Type of Service	Metal Parts	Spring(s)	O-Rings	Faces
Potable water.	316 or 316L Stainless Steel	316 or Hastelloy C	Buna-N or Viton	Silicon Carbide on Carbon

.6 Provide connections for cooling/flushing water.

.7 Acceptable Manufacturers are:

.1 Durametallic.

.2 John Crane.

.3 Chesterton.

2.4 Packing

.1 Packing can be used only where noted in the Specifications of the particular pump.

.2 Provide a minimum of five (5) rows of packing material suitable for the medium being pumped.

.3 Provide bronze lantern rings that are externally adjustable.

2.5 Stuffing Boxes

.1 Integrally cast the stuffing box with the motor mounting bracket, providing adequate area for the internal recirculation of the flushing/cooling fluid around the sealing medium.

.2 Provide a tapped and plugged hole for external flushing/cooling water.

2.6 Bearings

.1 Refer to Section 11000.

2.7 Protective Guards

.1 Provide a protective guard for all couplings and keys, drive belts, or other exposed rotating devices. As a minimum, conform to the requirements of Section 11000 – Equipment General Provisions.

2.8 Couplings

.1 For all pumps other than submersible and where noted otherwise in the detailed Specifications, provide flexible, double disc spacer type couplings conforming to Section 11000.

.2 Design couplings so that the pump unit can be disassembled without disturbing face piping.

2.9 Shafts

.1 Design shafts to absorb 1.15 times the rated power of the motors required to drive the pumps when the pump is fitted with maximum size impellers.

2.10 V-Belt Drives

.1 Do not use V-belt drives unless specified or shown on the Drawings.

.2 Conform to the requirements of Section 11000 - Equipment General Provisions.

.3 Where V-belt drives are indicated, ensure that the pump motor can handle operating speeds 20% higher than required for the specified operating points.

2.11 Tagging Instructions

.1 Tag loose items associated with a particular unit with the equipment number. Use aluminum or stainless steel (no plastic) tags securely attached to each item.

.2 Identification used shall be the same as the symbol indicated in the Specifications or on the Drawings and shall be located in a conspicuous place as acceptable to the Contract Administrator.

2.12 Spare Parts

.1 For each pump, provide for one spare mechanical seal or packing kit (as applicable) and one (1) set of pump bearings.

.2 For each centrifugal pump type and size, provide a single impeller, wear plate, suction ring (if replaceable), one pump shaft and nut.

.3 For spare parts for positive displacement pumps, provide as a minimum, one (1) wearing element. Refer to related pump Specifications for the specific spare part requirements.

2.13 Factory Performance Testing

.1 Where required for specific pumps, as noted in the Sections related to those pumps, factory performance test all pumps.

.2 Conduct factory performance testing in compliance with the Hydraulic Institute Standards.

.3 Inform Contract Administrator at least three (3) weeks prior to the factory testing to allow for his attendance.

.4 Certify test results and summarize findings in a short report. Submit report to the Contract Administrator within three (3) weeks of completing factory tests.

.5 Where the pump(s) does not satisfy the specified performance requirements within the tolerances specified by the Hydraulics Institute, redesign, modify, and re-test the pump(s), all at no additional cost.

.6 Do not ship the pump(s) until the test result report has been submitted to the Contract Administrator.

2.14 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings, or request deviation for approved equal at shop drawing submittal for Manufacturer's standard coating.

2.15 Motors

.1 Provide all motors in accordance with Section 11301 – Process Motors.

3. EXECUTION

3.1 General

.1 Comply with the requirements of the specific Sections for the pumps to be provided.

3.2 Installation

.1 Comply with the requirements of Section 01650 – Equipment Installation and any special requirements listed in the specific Sections related to each pump.

3.3 Testing

.1 The Contractor shall field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance. The Contractor shall record the results of the testing and provide as required, clarification of testing procedures, or any additional information necessary to complete testing in an appropriate manner.

.2 The Contractor shall provide temporary connections, flow monitoring, pressure monitoring, ammeters, and temporary tankage required for the performance of the tests.

.3 Flow Metering

.1 Where possible, use fill and draw techniques to determine the amount of flow conveyed during the test period. Ensure that the volumes are sufficient for at least five (5) minutes of pump operation at the flows that are to be tested, other than runout.

.2 Where permanent flow meters are installed on the downstream piping, they may be used to measure the flow during testing when accepted by the Contract Administrator. Ensure that the permanent flow meters are calibrated to within 5% of the rated flow of the pump to be tested prior to testing.

.3 Temporary metering may be used if accepted by the Contract Administrator. Temporary meters must have an accuracy of plus or minus 5%, at the rated flow of the pump, to be acceptable.

.4 Where other methods are not possible or where directed, use dye testing to determine the flow during the test periods. Dye testing is to be conducted by an agency acceptable to the Contract Administrator. Measured flows during the testing will be certified by a qualified Representative of the Contract Administrator to be within 5% of the actual flows.

.4 Pressure Monitoring

.1 Do not use permanent gauges for pressure monitoring during tests. Temporary test gauges can be connected to the permanent gauge taps.

.2 Use gauges with sufficient accuracy to measure anticipated pressures on pump discharges within 2.5%. Where pump suction draws from an open tank or wet well, test gauge must be capable of measuring pressure at pump suction within 1.0 kPa.

.3 Provide evidence of pressure gauge calibration within three (3) months of conducting tests.

.5 Test pump(s) at a minimum of three (3) flow conditions, typically corresponding to the rating point flow, 75% of that flow, and 120% of that flow. At each test point, measure flow, pressure, and amperage. In addition, verify run-out conditions.

.6 For variable speed pumps, conduct the tests at two (2) speeds, typically 100% of the design speed and 30% of the design speed, plus other design tests as described in the individual pump specifications and data sheets.

.7 Field Test Report

.1 Compile field test results into a report for submittal to the Contract Administrator.

.2 Describe test set-up and measurement devices used to conduct the tests.

.3 For each pump, list the specified performance requirements and field test results. Show field test results (flow, pressure, power draw) superimposed on the performance curve provided with the submissions.

.8 Where field tests do not verify compliance with specified performance requirements; investigate cause for noncompliance, undertake remedial Work as required to bring pump into compliance or replace the pump and all necessary ancillaries, and retest to prove compliance. All Work required to bring the pump into compliance is the responsibility of the Contractor and shall be performed at the Contractor's cost.

END OF SECTION

PROCESS MOTORS

1. GENERAL

1.1 Related Sections

.1 This Section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this Section.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 CSA C22.2 No. 100, Motors and Generators.

.2 CSA C22.2 No. 145, Motors and Generators For use in Hazardous Locations.

.3 CSA C390, Energy Efficiency Test Methods for Three-Phase Induction Motors.

.4 ABMA:

.1 9, Load Ratings and Fatigue Life for Ball Bearings.

.2 11, Load Ratings and Fatigue Life for Roller Bearings.

.5 ANSI: C50.41, Polyphase Induction Motors for Power Generating Stations.

.6 IEEE:

.1 85, Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.

.2 112, Standard Test Procedures for Polyphase Induction Motors and Generators.

.3 114, Standard Test Procedures for Single-Phase Induction Motors.

.4 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Motors.

.5 841, Standard for Petroleum and Chemical Industry – Severe Duty TEFC Squirrel Cage Induction Motors – up to and Including 500 hp.

.7 NEMA:

.1 MG 1, Motors and Generators.

.2 MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.

.3 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

.8 Ontario Electrical Safety Code 23 edition, 2002. (OESC).

.9 ULc:

.1 1, Flexible Metal Conduit.

.2 674, Standard for Safety Electric Motors and Generators for use in Division 1 Hazardous (Classified) Locations.

.3 2111, Overheating Protection for Motors.

.10 EEMAC Standard M1-6, Motors and Generators.

.11 EEMAC Standard MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

1.3 Definitions

.1 CISD-TEFC: Chemical industry, severe-duty enclosure.

.2 EXP: Explosion-proof enclosure.

.3 ODP: Open drip-proof enclosure.

.4 TEFC: Totally enclosed, fan cooled enclosure.

.5 TENV: Totally enclosed, nonventilated enclosure.

.6 WPI: Open weather protected enclosure, Type I.

.7 WPII: Open weather protected enclosure, Type II.

.8 Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

.9 Inverter Duty Motor: Motor meeting all applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

1.4 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Descriptive information.

.2 Nameplate data in accordance with NEMA MG 1.

.3 Additional Rating Information:

.1 Service factor.

.2 Locked rotor current.

.3 No load current.

.4 Safe stall time for motors 300 horsepower and larger.

.5 Multi-speed load classification (e.g. variable torque).

.6 Variable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.

.7 Guaranteed minimum full load efficiency and power factor.

.4 Enclosure type and mounting (e.g. horizontal, vertical).

.5 Dimensions and total weight.

.6 Conduit box dimensions and usable volume as defined in NEMA MG 1 and OESC.

.7 Bearing type.

.8 Bearing lubrication.

.9 Bearing life.

.10 Space heater voltage and watts.

.11 Description, ratings, and wiring diagram of motor thermal protection.

.12 Motor sound power level in accordance with NEMA MG 1.

.13 Maximum brake horsepower required by the equipment driven by the motor.

.14 Description and rating of submersible motor moisture sensing system.

.2 Information Submittals:

.1 Factory test reports, certified for motors 300 horsepower and larger.

.2 Operation and maintenance data.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 GE Canada.

.2 Leeson Canada.

.3 Reliance Electric.

.4 MagneTek.

.5 Siemens Energy and Automation, Inc., Motors and Drives Division.

.6 Baldor.

.7 U.S. Electrical Motors.

.8 TECO-Westinghouse Motor Co.

.9 Toshiba International Corp., Industrial Division.

2.2 General

.1 For multiple units of the same type of equipment, furnish identical motors and accessories of a single Manufacturer.

.2 In order to obtain single source responsibility, a drive motor, its driven equipment, and specified motor accessories shall be supplied as a Vendor Package.

.3 Meet requirements of NEMA MG 1.

.4 Frame assignments in accordance with NEMA MG 13.

.5 Provide motors for hazardous (classified) locations that conform to OESC and have an applied CSA listing mark.

.6 Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

.7 Lifting lugs on all motors weighing 45 kg or more.

.8 Operating Conditions:

.1 Maximum ambient temperature not greater than 40 degrees C.

.2 Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.

.3 Overspeed in either direction in accordance with NEMA MG 1.

2.3 Horsepower Rating

.1 As designated in motor-driven equipment specifications.

.2 Constant Speed Applications: Brake horsepower of the driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

.3 Variable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding any service factor.

2.4 Service Factor

.1 1.15 minimum at rated ambient temperature, unless otherwise indicated.

2.5 Voltage and Frequency Rating

.1 System Frequency: 60-Hz.

.2 Voltage Rating: Unless otherwise indicated in motor-driven equipment specifications:

Size	Voltage	Phases
0.37 kW and smaller	115	1
0.56 kW through 298 kW	575	3

.3 Suitable for full voltage starting.

.4 74.6 kW and larger also suitable for solid state reduced voltage starting.

.5 Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.6 Efficiency and Power Factor

.1 For all motors except single-phase, under 1 horsepower, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

.1 Efficiency:

.1 Tested in accordance with CSA C390, paragraph 12.59.

.2 Guaranteed minimum at full load in accordance with NEMA MG 1 Table 1, Supplement, or as indicated in motor-driven equipment specifications.

.2 Power Factor: Guaranteed minimum at full load in accordance with Table 1 or as indicated in motor-driven equipment specifications.

2.7 Locked Rotor Ratings

.1 Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.

.2 Safe stall time 12 seconds or greater.

2.8 Insulation Systems

.1 Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

.2 Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

.3 Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP motors which must be Class B with Class B rise**.**

2.9 Enclosures

.1 Enclosures to conform to NEMA MG 1.

.2 TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

.3 EXP:

.1 TEFC listed to meet requirements for Class I, Zone 1 or 2 (as required in the application), Group C and D hazardous locations.

.2 Drain holes with drain and breather fittings.

.3 Integral thermostat opening on excessive motor temperature in accordance with OESC.

.4 Terminate thermostat leads in terminal box separate from main terminal box.

.4 Submersible: In accordance with Article Special Motors.

.5 CISD-TEFC: In accordance with Article Special Motors.

.6 All motors to be minimum TEFC.

2.10 Terminal (Conduit) Boxes

.1 Oversize main terminal boxes for all motors.

.2 Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

.3 Except ODP, furnish gaskets between box halves and between box and motor frame.

.4 Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19:

Terminal Box Usable Values		
Voltage	**kW**	**Percentage**
Below 600	11.2 through 93	500
Below 600	111 through 224	275
Below 600	261 through 447	225
Above 600	All sizes	200

.5 Terminal for connection of equipment grounding wire in each terminal box.

2.11 Bearings and Lubrication

.1 Horizontal Motors:

.1 0.56 kW and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

.2 0.75 through 298 kW: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

.3 Above 298 kW: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.

.4 Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and 11.

.2 Vertical Motors:

.1 Thrust Bearings:

.1 Antifriction Plate type (Kingsbury) bearing.

.2 Manufacturer's standard lubrication 74.6 kW and smaller.

.3 Minimum 50,000 hours L-10 bearing life.

.2 Guide Bearings:

.1 Manufacturer's standard bearing type.

.2 Manufacturer's standard lubrication 149 kW and smaller.

.3 Minimum 100,000 hours L-10 bearing life.

.3 Regreasable Antifriction Bearings:

.1 Readily accessible, grease injection fittings.

.2 Readily accessible, removable grease relief plugs.

.4 Oil Lubrication Systems:

.1 Oil reservoirs with sight level gauge.

.2 Oil fill and drain openings with opening plugs.

.3 Provisions for necessary oil circulation and cooling.

.5 Bearing Isolation: Motors rated for inverter duty shall have electrically isolated bearings to prevent stray current damage.

2.12 Noise

.1 Measured in accordance with IEEE 85 and NEMA MG 1.

.2 Motors controlled by variable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 Balance and Vibration Control

.1 In accordance with NEMA MG 1, Part 7.

2.14 Equipment Finish

.1 Protect Motor for Service Conditions:

.1 ODP Enclosures: Indoor industrial atmospheres.

.2 Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure

.2 External Finish: Prime and finish coat Manufacturer's standard.

.3 Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 Special Features and Accessories

.1 Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for Guarded Machine in NEMA MG 1, and attached with stainless steel screws.

.2 Winding Thermal Protection:

.1 Provide thermostats, thermistors, and RTDs as indicated on the P&IDs and control drawings.

.3 Bearing Temperature Protection:

.1 As indicated in P&IDs.

.4 Vibration detection relay mounted in NEMA 250, Type 4X enclosure on side of motor, when indicated.

.5 Nameplates:

.1 Raised or stamped letters on stainless steel or aluminum.

.2 Display motor data required by NEMA MG 1, paragraphs 10.39 and 10.40 in addition to bearing numbers for both bearings.

.3 Premium efficiency motor nameplates to also display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

.6 Anchor Bolts: Provide anchor bolts meeting Manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

2.16 Special Motors

.1 Requirements in this article take precedence over conflicting features specified elsewhere in this Section.

.2 CISD-TEFC:

.1 In accordance with IEEE 841.

.2 TEFC in accordance with NEMA MG 1.

.3 Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.

.4 Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.

.5 Ventilating Fan: Corrosion-resistant, nonsparking, external.

.6 Drain and Breather Fittings: Stainless steel.

.7 Nameplate: Stainless steel.

.8 Gaskets between terminal box halves and terminal box and motor frame.

.9 Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.

.10 Double shielded bearings.

.11 125,000 hours minimum L-10 bearing life for direct-connected loads.

.12 External Finish: Double-coated epoxy enamel.

.13 Coated rotor and stator air gap surfaces.

.14 Insulation System, Windings, and Connections:

.1 Class F insulation, Class B rise or better at 1.0 service factor.

.2 Multiple dips and bakes of nonhygroscopic polyester varnish.

.15 Service Factor:

.1 At 40 Degrees C Ambient: 1.15.

.2 At 65 Degrees C Ambient: 1.00.

.16 Safe Stall Time Without Injurious Heating: 20 seconds minimum.

.3 Severe-Duty Explosion-Proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

.4 Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.

.5 Inverter Duty Motor:

.1 Motor supplied power by adjustable voltage and variable frequency drives shall be inverter duty rated.

.2 Motor shall be suitable for operation over entire speed range indicated.

.3 Provide forced ventilation where speed ratio is greater than published range for motor being installed.

.4 Motor installed in Class I, Zone 1 or 2 hazardous (classified) locations shall be identified as acceptable for variable speed when used in a these hazardous locations.

.6 Submersible Pump Motor:

.1 As per Pump Manufacturers.

.2 At 100 Percent Load:

Submersible Pump Motors		
kW	Guaranteed Minimum Efficiency	Guaranteed Minimum Power Factor
3.7 through 7.4	80	82
7.5 through 37.3	85	82
37.4 through 74.6	87	82
Over 74.6	89	82

.3 Insulation System: Manufacturer's standard Class B or Class F.

.4 Motor capable of running dry continuously.

.5 Enclosure:

.1 Hermetically sealed, watertight, for continuous submergence up to 20 meters depth.

.2 Listed to meet OESC requirements for Class I, Zone 1 and 2 Group C and D hazardous atmosphere.

.3 Seals: Tandem mechanical.

.6 Bearing and Lubrication:

.1 Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.

.2 Minimum 15,000 hours L-10 bearing life.

.7 Inrush kVA/horsepower no greater than NEMA MG 1 and Code F rating.

.8 Winding Thermal Protection:

.1 Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.

.2 Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.

.3 Switch contacts rated at 5 amps, 120V ac.

.9 Motor Seal Failure Moisture Detection:

.1 Probes or sensors to detect moisture beyond seals.

.2 Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120V ac supply.

.3 Monitoring module with control power transformer, probe test switch and test light, and two independent 120V ac contacts, one opening and one closing when the flux of moisture is detected.

.10 Bearing Overtemperature Protection for Motors Larger than 100 horsepower:

.1 Sensor on lower bearing housing monitoring bearing temperature.

.2 Any monitoring relay necessary to provide 120V ac contact opening on bearing overtemperature.

.11 Winding thermal protection, moisture detection, and bearing overtemperature specified above may be monitored by a single device providing two independent 120V ac contacts, one closing and one opening on malfunction.

.12 Connecting Cables:

.1 Two separate cables, one containing power and grounding conductors, and the other containing control and grounding conductors.

.2 Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.

.3 Length: 10 meters minimum.

.4 CSA listed and sized in accordance with OESC.

.7 Inclined Motors:

.1 Motors suitable for operation only in horizontal position not acceptable.

.2 Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.

.3 Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 Factory Testing

.1 Tests:

.1 In accordance with CSA C390 for polyphase motors and for single-phase motors.

.2 Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current. Test multispeed motors at all speeds.

.3 For energy efficient motors, test efficiency at 50, 75, and 100 percent of rated horsepower:

.1 In accordance with CSA C390 or IEEE 112, Test Method B, and NEMA MG 1, paragraphs 12.59. and 12.60.

.2 For motors 500 horsepower and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by CSA C390 or IEEE 112, Test Method F.

.4 Power Factor:

.1 Speed.

.2 Current at rated horsepower.

.3 kW input at rated horsepower.

.4 On motors 74.6 kW and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

.5 Vibration (balance).

.2 Test Report Forms:

.1 Routine Tests: IEEE 112, Form A-1.

3. EXECUTION

3.1 Installation

.1 In accordance with Manufacturer's instructions and recommendations.

.2 Align motor carefully and properly with driven equipment.

.3 Secure equipment to mounting surface with anchor bolts.

3.2 Field Quality Control

.1 Refer to Section 16030, Electrical Testing.

3.3 Manufacturer's Services

.1 Furnish Manufacturer's representative at Site for installation assistance, inspection, equipment testing, and startup assistance for motors larger than 223.4 kW, unless otherwise noted.

3.4 Supplements

.1 Table supplements, following "End of Section," are part of this Specification.

.1 Table 1 - Motor Performance Requirements.

END OF SECTION

TABLE 1
MOTOR PERFORMANCE REQUIREMENTS

		% Guar. Min. Full Load Efficiency				% Guar. Min. Full Load Power Factor			
		Horizontal		Vertical		Horizontal		Vertical	
hp	Nom.Speed rpm	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC	Drip-proof ODP	TEFC
1	1,800	82.5	82.5			Mfr.'s Std.	Mfr.'s Std.		
	1,200	80.0	80.0			Mfr.'s Std.	Mfr.'s Std.		
1.5	3,600	82.5	82.5			Mfr.'s Std.	Mfr.'s Std.		
	1,800	84.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1,200	84.0	85.5		82.0	Mfr.'s Std.	Mfr.'s Std.		Mfr.'s Std.
2	3,600	84.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1,800	84.0	84.0			Mfr.'s Std.	Mfr.'s Std.		
	1,200	85.5	86.5	83.7	83.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	82.9	82.5	82.9	81.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
3	3,600	84.0	85.5	82.0	82.0	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	86.5	87.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	86.5	87.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	84.1	83.0	84.1	82.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

5	3,600	85.5	87.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	87.5	87.5	84.8	84.8	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	87.5	87.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	85.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
7.5	3,600	87.5	88.5	84.8	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	88.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	88.5	89.5	88.4	87.5	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	87.5	85.5	87.5	86.6	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
10	3,600	88.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	89.5	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
15	3,600	89.5	90.2	88.4	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	91.0	91.0	90.9	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	90.2	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	89.3	88.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
20	3,600	90.2	90.2	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	91.0	91.0	91.7	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	91.0	90.2	90.2	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
25	3,600	91.0	91.0	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	91.7	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.

	1,200	91.7	91.7	90.9	89.3	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	90.2	89.5	89.3	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
30	3,600	91.0	91.0	89.5	88.4	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,800	92.4	92.4	92.4	91.7	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	1,200	92.4	91.7	91.7	90.2	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
	900	91.7	91.0	90.9	90.9	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.	Mfr.'s Std.
40	3,600	91.7	91.7	90.2	89.3	86.6	86.1	87.0	89.0
	1,800	93.0	93.0	92.8	91.7	78.2	78.2	83.0	84.5
	1,200	93.0	93.0	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.0	90.9	90.2	70.0	70.5	70.0	70.5
50	3,600	92.4	92.4	90.2	89.3	85.1	86.7	89.0	89.0
	1,800	93.0	93.0	92.8	91.7	79.5	79.4	82.5	82.5
	1,200	93.0	93.0	91.7	90.9	81.5	81.5	81.5	81.5
	900	91.7	91.7	90.9	90.9	78.5	72.9	78.5	80.0
60	3,600	93.0	93.0	91.7	90.9	85.8	88.3	87.5	89.0
	1,800	93.6	93.6	93.5	92.8	80.5	79.9	80.5	80.5
	1,200	93.6	93.6	92.8	91.7	81.5	81.5	81.5	81.5
	900	92.4	91.7	91.7	90.9	79.5	73.2	79.5	79.5
75	3,600	93.0	93.0	91.7	91.7	87.1	88.5	88.5	88.5
	1,800	94.1	94.1	93.5	93.5	81.0	81.5	81.0	81.5
	1,200	93.6	93.6	93.5	92.8	82.0	82.0	82.0	82.0

	900	92.8	92.4	92.8	91.7	80.5	74.5	80.5	81.0
100	3,600	93.0	93.6	91.7	91.7	87.0	88.2	87.0	88.5
	1,800	94.1	94.5	94.0	93.5	81.0	81.0	81.0	81.0
	1,200	94.1	94.1	92.8	92.8	82.1	81.7	85.5	85.5
	900	93.5	92.4	92.8	91.7	77.0	77.3	77.0	80.0
125	3,600	93.6	94.5	91.7	91.7	86.4	89.1	87.0	90.5
	1,800	94.5	94.5	93.5	92.8	85.4	85.5	87.5	86.0
	1,200	94.1	94.1	93.5	92.8	82.7	82.3	85.5	85.5
	900	93.5	93.0	92.8	92.4	78.5	78.5	78.5	78.5
150	3,600	93.6	94.5	92.4	91.7	86.5	90.0	86.5	90.5
	1,800	95.0	95.0	94.5	94.0	82.5	85.0	84.5	85.0
	1,200	94.5	95.0	93.5	94.0	81.5	81.5	81.5	81.5
	900	93.5	93.0	92.8	92.4	78.0	78.5	78.0	78.5
200	3,600	94.5	95.0	92.4	93.0	87.8	89.4	91.0	91.0
	1,800	95.0	95.0	94.0	94.0	85.2	86.5	87.0	87.0
	1,200	94.5	95.0	93.5	93.5	79.0	82.5	79.0	82.5
250	3,600	95.0	95.0	91.7	92.4	85.0	86.5	85.0	86.5
	1,800	96.0	96.0	94.5	94.5	79.0	79.0	79.0	79.0
	1,200	95.0	95.0	94.5	93.5	82.0	82.0	82.0	82.0

300	3,600	95.0	95.0			89.8	89.9		
	1,800	95.4	95.2	94.5	94.0	80.0	80.0	80.0	80.0
	1,200	95.0	95.0			84.5	90.1		
350	3,600	95.0	95.0			89.4	85.9		
	1,800	95.0	95.0			85.9	85.9		
400	3,600	95.0	95.0			88.4			
	1,800	95.0	95.0			86.8			
450	3,600	95.0	95.0			89.1			
500	3,600	95.0	95.0			88.3			

PROCESS SUBMERSIBLE PUMPS

1. GENERAL

1.1 References

.1 The following is a list of standards that may be referenced in this Section:

.1 American Society for Testing and Materials (ASTM):

.1 A48, Standard Specification for Gray Iron Castings.

.2 A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

.2 Hydraulic Institute Standards (HIS).

.3 National Electric Code (NEC).

.4 National Electrical Manufacturers Association (NEMA).

.5 National Fire Protection Association (NFPA): 70, National Electric Code.

.6 Underwriters Laboratories (UL).

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to Section 11300 – Process Pumps General Requirements, and ratings and nomenclature of the Hydraulic Institute Standards.

1.3 Submittals

.1 Shop Drawings, Refer to Section 01300 - Submittals:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.

.4 Detailed mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.5 Power and control wiring diagrams, including terminals and numbers.

.6 Control Panel external face layout and inter layout drawings and electrical wiring diagrams.

.7 Complete motor nameplate data, as required by NEMA, from motor Manufacturer.

.8 Factory finish system.

.9 Bearing life calculations.

.10 Certified shop test results for motor vibration measurements.

.2 Quality Control Submittals:

.1 Factory and field performance test reports and logs.

.2 Manufacturer's certification of compliance that factory finish system meets requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions, including pump specific vibration and alignment tolerances.

.5 Suggested spare parts list to maintain equipment in service for period of 1 year and 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Provide an operation and maintenance manual and maintenance summary in conformance with the requirements of Division 1, General Requirements, and Section 01730 – Operation and Maintenance Manuals.

.8 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.9 External utility requirements: air, water, power, etc. for each component.

1.4 Extra Materials

.1 Furnish for each size of pumps:

.1 One set mechanical seals.

.2 One complete set of special tools required to dismantle pump.

2. PRODUCTS

2.1 General

.1 Refer to Section 11300 - Process Pump General Requirements.

.2 Refer to Section 11301 – Process Motors.

.3 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid.

.4 The supply of process submersible pumps under this Section shall come from a single Manufacturer.

2.2 Supplements

.1 Pump datasheet and any other specific requirements are attached to this Section as supplements.

2.3 Components

.1 Pump equipment shall consist of pump(s) complete with motor(s), control system where applicable, guide rail and anchoring brackets, base elbow, power cable(s), and pump lifting cable(s).

.1 Pump metal parts that come into contact with guide rail or cable system shall be made of nonsparking materials.

.2 Control panel, level switches and level transmitters, where indicated.

.2 Lifting Arrangement: 2500 mm minimum, stainless steel chain, and one “grip-eye.” Attach chain permanently to pump and access platform with stainless steel wire rope. “Grip-eye” will be capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with “grip-eye” and independent hoist.

.3 Sliding guide bracket shall be integral part of pump unit. Pump unit shall be guided by no less than 2 guide bars, or equivalent cable system, and pressed tightly against discharge connection elbow with metal-to-metal contact or through use of profile-type gasket, provided that gasket is attached to pump’s flange and can be easily accessed for inspection when pump is lifted out of wetwell.

.4 Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti-leak seal and shall be easily accessible from outside. Provide leak detection output signal to control panel.

.5 Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

.6 Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cable shall be of sufficient length to reach junction boxes without strain or splicing.

.7 Cable Entry System:

.1 Junction chamber and motor shall be separated by stator lead sealing gland or terminal board that shall prevent foreign material entering through pump top.

.2 Utilize cable with factory-installed sealing gland with nonshrink epoxy seal system.

.3 O-ring compression seal between sealing gland and cable entry point shall also be acceptable.

.8 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.4 Control Panel

.1 Refer to Section 16991 –Control Panels. Local control panels are part of Vendor Packages, as indicated on contract drawings.

.2 Provide NEMA 4 316 stainless steel enclosure for indoor duty, for each pump system as noted on contract drawings. Panels shall be in conformance with the requirements of Div 16 and 17.

.3 Free standing, post mounted.

.4 Control panel shall include the following as further described in contract drawings:

.1 Main circuit breaker disconnect interlocked with panel door.

.2 Combination circuit breaker type, NEMA rated motor starters.

.3 Fused control power transformer, 120V ac.

.4 COMPUTER/OFF/HAND switches.

.5 Running lights.

.6 Contact closure inputs for:

.1 Low level interlock

.2 Remote start

.7 Normally closed, dry, 5 amps at 120V ac contacts for remote indication of:

.1 Running.

.2 Pump failure (temperature or moisture alarm).

.3 Computer

.8 Terminal strip for interfacing with external wiring.

.9 High temperature indication.

.10 Moisture alarm indication.

.11 Document pocket located inside panel with pump and panel operation and maintenance manual and separate laminated pump curve.

.12 Run hour meter.

.13 CSA labeled panel.

.5 Prewired and factory tested.

.6 Mount control switches, indicating lights, and switches on hinged front panel.

.7 Single Feed: 575 volt, three-phase.

.8 Refer to Division 16 for VFD requirements if specified in pump datasheets.

2.5 Accessories

.1 Equipment Identification Plate: 16-gauge stainless steel with 6 mm die-stamped equipment tag number securely mounted in readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kg.

.3 Anchor Bolts: Type 316L stainless steel, sized by equipment Manufacturer.

2.6 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 - Factory Applied Protective Coatings.

2.7 Source Quality Control

.1 Control Panel:

.1 Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

.2 Factory Tests and Adjustments: Test all control panels furnished.

.2 Pump:

.1 Factory Performance Test:

.1 In accordance with HIS 1.6, for centrifugal pump tests.

.2 Include test data sheets, curve test results, performance test logs.

.2 Conduct on each pump.

.3 Perform under actual or approved simulated operating conditions.

.1 Throttle discharge valve to obtain pump data points on curve at 2/3, 1/3, and shutoff conditions.

.4 Vibration Test:

.1 Motors for commercial shop test in operation at design loads shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.3 mm or velocities in excess of 6 mm/sec..

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Motor Functional Test: Perform Manufacturer's standard motor test. Submerge and run for 30 minutes at pumping conditions corresponding to maximum motor load.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be in accordance with the Manufacturer’s printed installation instructions. Installation includes but is not limited to:

.1 Connect suction and discharge piping without imposing strain to pump flanges.

.2 No portion of pump shall bear directly on floor of sump.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901 – Painting and Finishing - Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Flow Output: Flow and discharge pressure measured by WTP instrumentation and storage volumes.

.3 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment under this Section are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100

2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	6	103
5	Operator and Maintenance Training	6	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Backwash Area Process Sump Pumps: P-F981A, P-F982A, P-F983A, P-F984A

.2 DAF Influent Gallery Process Sump Pumps: P-P981A, P-P982A, P-P983A

.3 Fire Pump Room Flood Pumps: P-B981A, P-B982A

.4 WRT Sludge Pumps: P-R100C, P-R200C, P-R300C, P-R400C

END OF SECTION

SUPPLEMENT 1 – BACKWASH AREA PROCESS SUMP PUMPS

PARAMETER	VALUE
Tag No. (s)	P-F981A, P-F982A
Design Point Flow Capacity (L/sec)	28.4
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	10.4
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer
Flow Operating Range (cubic metres/day)	N/A
Total Dynamic Head (TDH) Operating Range (m)	N/A
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	229.25
Area Finished Floor (Geodetic) (m)	230.25
Sump Bottom Elevation (Geodetic) (m)	228.75
Centreline Pump Discharge (Geodetic) (m)	232.2 ±
Driver Maximum (kW)	7.5
Driver Voltage (V/phase/frequency)	575/3/60
Max Speed (rpm)	1800
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	56
Acceptable Manufacturers	ITT Flygt, Model NP-3127 Weir Flowserve KSB

N/A – not applicable.

SUPPLEMENT 2 – BACKWASH AREA PROCESS SUMP PUMPS

PARAMETER	VALUE
Tag No. (s)	P-F983A
Design Point Flow Capacity (L/sec)	164
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	10.4
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer
Flow Operating Range (cubic metres/day)	N/A
Total Dynamic Head (TDH) Operating Range (m)	N/A
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	229.75
Area Finished Floor (Geodetic) (m)	230.25
Sump Bottom Elevation (Geodetic) (m)	228.75
Centreline Pump Discharge (Geodetic) (m)	232.00 ±
Driver Maximum (kW)	35
Driver Voltage (V/phase/frequency)	575/3/60
Max Speed (rpm)	1800
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	60
Acceptable Manufacturers	ITT Flygt, Model NP-3202 Weir Flowserve KSB

N/A – not applicable.

SUPPLEMENT 3 – BACKWASH AREA PROCESS SUMP PUMPS

PARAMETER	VALUE
Tag No. (s)	P-F984A
Design Point Flow Capacity (L/s)	1.96
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	1.7 [1]
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer
Flow Operating Range (cubic metres/day)	N/A
Total Dynamic Head (TDH) Operating Range (m)	1.25 – 2.25
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	228.75
Area Finished Floor (Geodetic) (m)	230.25
Sump Bottom Elevation (geodetic) (m)	228.55
Centreline Pump Discharge (Geodetic) (m)	By Manufacturer
Driver Maximum (kW)	0.37 ±
Driver Voltage (V/phase/frequency)	230/1/60
Max Speed (rpm)	3450
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	60
Acceptable Manufacturers	ITT Flygt Weir Flowserve KSB

Note 1: Additional head with throttling may be required to achieve optimal pump sizing.

N/A – not applicable.

SUPPLEMENT 4 – DAF INFLUENT GALLERY PROCESS SUMP PUMPS

PARAMETER	VALUE
Tag No. (s)	P-P981A
Location	DAF Influent Gallery
Design Point Flow Capacity (cubic metres/day)	3455
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	4.08
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer
Net Positive Suction Head Available (NPSHA) (Head (m) at Design Flow)	10.55
Flow Operating Range (cubic metres/day)	Minimum: 3455
Total Dynamic Head (TDH) Operating Range (m)	4.93 to 5.31
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	By Manufacturer
Area Finished Floor (Geodetic) (m)	233.17
Sump Bottom Elevation (Geodetic) (m)	231.17
Centreline Pump Discharge (Geodetic) (m)	By Manufacturer and as close to the floor as possible (approx. 231.410) ±
Driver Maximum (kW)	4.88
Driver Voltage (V/phase/frequency)	575/3/60
Max Speed (rpm)	1800
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	60
Acceptable Manufacturers	ITT Flygt Weir Flowserve KSB

N/A – not applicable.

SUPPLEMENT 5 – DAF INFLUENT GALLERY PROCESS SUMP PUMP

PARAMETER	VALUE
Tag No. (s)	P-P982A, P-P983A
Location	DAF Influent Gallery
Design Point Flow Capacity (cubic metres/day)	Primary: 15120
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	Primary: 5.75
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer
Net Positive Suction Head Available (NPSHA) (Head (m) at Design Flow)	10.18
Flow Operating Range (cubic metres/day)	Minimum: 15120
Total Dynamic Head (TDH) Operating Range (m)	4.93 to 6.56
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	By Manufacturer
Area Finished Floor (Geodetic) (m)	233.17
Sump Bottom Elevation (Geodetic) (m)	231.17
Centreline Pump Discharge (Geodetic) (m)	By Manufacturer and as close to the floor as possible (approx. 231.670) ±
Driver Maximum (kW)	18.75
Driver Voltage (V/phase/frequency)	575/3/60
Max Speed (rpm)	1200
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	65
Acceptable Manufacturers	ITT Flygt Weir Flowserve KSB

N/A – not applicable.

SUPPLEMENT 6 – FIRE PUMP ROOM FLOOD PUMPS

PARAMETER	VALUE	VALUE
Tag No. (s)	P-B981A	P-B982A
Design Point Flow Capacity (L/sec)	30	150
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	5.0	5.0
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	N/A	N/A
Flow Operating Range (cubic metres/day)	N/A	N/A
Total Dynamic Head (TDH) Operating Range (m)	N/A	N/A
Fluid Temperature Operating Range (◦C)	0.5-25	0.5-25
Solids Concentration Operating Range (%)	N/A	N/A
Minimum Suction Water Elevation (Geodetic) (m)	N/A	N/A
Area Finished Floor (Geodetic) (m)	234.5	234.5
Sump Bottom Elevation (Geodetic) (m)	232.8	232.8
Centreline Pump Discharge (Geodetic) (m)	235.0	235.0
Driver Maximum (kW)	3.7	18.6
Driver Voltage (V/phase/frequency)	600/3PH/60Hz	600/3PH/60Hz
Max Speed (rpm)	1800	1200
Outlet Diameter, mm	100	200
Motor Suitable for Variable Frequency Drive	N/A	N/A
Minimum Pump Efficiency at Design Point (%)	56	59
Acceptable Manufacturers	ITT Flygt Weir Flowserve KSB	ITT Flygt Weir Flowserve KSB

N/A – not applicable.

SUPPLEMENT 7 – WRT SLUDGE PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-R100C, P-R200C,P-R300C,P-R400C	
Design Point Flow Capacity (L/s)	Primary: 42	Secondary: 33
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	Primary: 14.7	Secondary: 12.7
Net Positive Suction Head (NPSH) Required (Head (m) at Design Flow)	By Manufacturer	
Net Positive Suction Head Available (NPSHA) (Head (m) at Design Flow)	By Manufacturer	
Minimum Geodetic Water Level in the Sump (m)	231.25	
Pump Sump Floor Elevation (m)	230.25	
Maximum Geodetic Water Level in the Sump (m)	233.14	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	0.01 - 0.06	
Top of Slab (400 mm slab incl.) Pump Station Floor Elevation	239.41	
Driver Maximum (kW)	9	
Driver Voltage (V/phase/frequency)	575/3/60	
Speed (max)	1650 rpm	
Motor Suitable for Variable Frequency Drive	Yes	
Minimum Pump Efficiency at Design Point (%)	69	
Acceptable Manufacturers	ITT Flygt Weir Flowserve KSB	

Note: Provide all guide rail system, chains, intermediate supports, anchor bolts, discharge connections etc. as required for complete working package.

GEAR PUMPS

1. GENERAL

1.1 References

.1 Pumps shall be in compliance with the appropriate sections of the following codes:

.1 NSF International, Standard 61 - Drinking Water System Components.

.2 American Gear Manufacturers Association (AGMA).

.3 AISC, American Institute of Steel Construction.

.4 AISC, American iron and Steel Institute.

.1 Type 416 Stainless Steel.

.2 Type 1035 Steel.

.3 Type 1045 Carbon Steel.

.4 Type 4140 Alloy Steel.

.5 American Iron and Steel Institute (AISI).

.6 American Bearing Manufacturers' Association (ABMA).

.7 American Society of Mechanical Engineers (ASME).

.8 American National Standards Institute (ANSI).

.9 American Society for Testing and Materials (ASTM).

.1 A48/A48M, Standard Specification for Gray Iron Castings.

.2 A53/A53M, Standard specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

.3 A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

.4 A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.

.5 B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 B148, Standard Specification for Aluminum Bronze Sand Castings.

.7 B584, Standard Specification for Copper Alloy Sand Castings for General Applications.

.10 CEC, Canadian Electrical Code.

.11 Canadian Standards Association (CSA).

.12 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.13 ESA, Electrical Safety Authority.

.14 Institute of Electrical and Electronics Engineers (IEEE)

.15 ISA, Instrument Society of America.

.16 NEC, National Electrical Code.

.17 National Electrical Manufacturer's Association (NEMA)

.18 NFPA, National Fire Protection Association.

.19 Steel Structures Painting Council (SSPC).

.20 Manitoba Building Code.

.21 CPC, Canadian Plumbing Code.

.22 OSHA, Occupational Safety & Health Act.

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to Section 11300 – Process Pumps General Requirements, and ratings and nomenclature of the Hydraulic Institute Standards.

1.3 Contractor Submittals

.1 Shop Drawings:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

.3 Performance data curves showing head, capacity, and pump efficiency over the entire operating range of the pump.

.4 Detailed drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.5 Power and control wiring diagrams, including terminals and numbers.

.6 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.

.7 Materials of construction

.8 Describe related appurtenances

.2 Quality Control Submittals:

.1 Factory Functional and Performance Test Reports.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Suggested spare parts list to maintain the equipment in service for a Period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Operation and maintenance manual.

2. PRODUCTS

2.1 General

.1 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid."

.2 The supply of gear pumps under this Section shall come from a single Manufacturer.

GEAR PUMPS

2.2 Pump Units

.1 Be responsible for selecting pumps, motors and variable frequency drives which will be capable of meeting the head, pressure, and max./min. flow and accuracy requirements of the system. Take into account the specific gravity, viscosity, corrosivity and temperature of the fluid being pumped.

.2 The pumps shall provide a constant flow rate for a particular drive speed and provide linear pulsation free output flow.

.3 The drive magnet shall be an encapsulated assembly mounted on the end of the pump shaft. The drive magnet assembly shall rotate around the containment can as a result of magnetic force.

.4 Construct the pump parts in contact with the fluid being pumped of materials suitable for the chemical application.

.5 Hydrogen Peroxide pump parts in contact with chemical to be of 316L stainless steel. Gears to be suitable for chemical being pumped.

.6 All gear pump motors to be totally enclosed fan cooled (TEFC), in accordance with Section 11301 – Process Motors.

.7 Variable frequency drives in accordance with Section 16815 – Variable Frequency Drives.

.8 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.3 Pumping Accuracy

.1 Provide a minimum pumping accuracy of ±5% over the operating full range for each combined pump, motor and variable frequency controller system.

.2 Combined pump, motor and variable frequency drive controller system to be capable of a minimum of 1000:1 flow control turndown.

2.4 Pump Skids

.1 General

.1 The pump shall come with factory fabricated pump skids as shown in the P&IDs and described herein.

GEAR PUMPS

.2 The hydrogen peroxide and SBS pump skids shall each contain three (3) pumps. Pump skids shall be sized appropriately to fit in the designated location in their respective chemical feed rooms, as shown on the drawings.

.3 All components of the chemical feed pump skids including pump, speed controller, motor, and related appurtenances unit shall be pre-plumbed and pre-wired. Skid shall be 316L stainless steel and fork truck compatible. Mounting hardware shall be 316L stainless steel.

.4 All actuated valves shall have 120/1/60 power supply

.2 Accessories

.1 Provide inline flow meters to measure the chemical flow from each metering pump. Flow meter shall be capable of accurately measuring flows from 0 to 300 L / hour. Flow meter wetted components to be chemically resistant to service being used. Meters to meet Division 17 Specifications. Flow meter to be Weber Inline Flow-Captor Type 4311.30 or approved equal.

.2 Each pump shall be supplied with pre-piped calibration column and pressure relief valve. The calibration column shall be constructed of clear PVC and shall be complete with a vented top cap and shall be graduated in milliliters. The hydrogen peroxide and SBS calibrations columns shall each have a minimum capacity of 2,000 ml.

.3 Provide pressure relief valves to vent trapped hydrogen peroxide gasses. Pressure relief valves shall be Swagelok 12mm SS-8CPA2-50 or approved equal.

1.2 Pump Skid Control Panels

.1 Each pump skid shall be supplied with a control enclosure housing electronic speed controller and the auxiliary control devices specified herein. The control enclosure shall be NEMA 4X. The enclosure front panel shall include a fusible disconnect switch, an "Computer-Off- Hand" selector, the VFD drive control interfaces, pump "Run" and "Fail" indicating lights and pump flow rate indication for each pump provided. In the "Hand" mode, the pump shall run continuously. In the "Computer" mode, the pump shall be controlled by the WTP PLC. Speed shall be controlled locally in the "Hand" mode, and from a remote 4-20 mA input signal when in the "Computer" mode.

.2 The control enclosure shall be supplied with a 575 VAC, 3 phase, 60 Hz power supply. Power will be supplied by Division 16. The Contractor shall supply load requirements for all supplies as a Shop Drawing submittal.

.3 The WTP PLC shall control the dose rate of the SBS and hydrogen Peroxide feed system based on totalized flow rates from their respective processes.

.4 The Hydrogen Peroxide feed pumps shall operate as follows:

.1 The Hydrogen Peroxide dose delivered to Cell 1 of Ozone Contactor No. 1 and No. 2 for advanced oxidation is flow-paced and set according to the applied ozone dose. Flow pacing shall be achieved through the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters. Hydrogen Peroxide pump No. 1 shall be flow paced by the Q_{total} of DAF units 1 to 4 and Hydrogen Peroxide pump No. 2 shall be flow paced by the Q_{total} of DAF units 5 to 8. The Hydrogen Peroxide dose is set by the applied ozone dose and calculated to be 0.5 to 0.8 mg hydrogen peroxide per mg of applied ozone. The target default dosage is 0.8 mg/L of hydrogen peroxide per mg of applied ozone, and can be adjusted by the operator.

.2 The dose delivered to Cell 6 of Ozone Contactor No. 1 and No. 2 for ozone quenching is flow-paced and adjusted based on the ozone residual measured in Cell 6 of the Ozone Contactor. The dose is calculated to be 0.5 to 0.8 mg hydrogen peroxide per mg of residual ozone. The target default dosage is 0.8 mg/L of hydrogen peroxide per mg of applied ozone, and can be adjusted by the operator.

.5 The SBS feed pumps shall operate as follows:

.1 Chemical dose is automatically calculated and controlled via control logic within the PLC. The dose delivered to Cell 6 of Ozone Contactor No. 1 and No. 2 for ozone quenching is flow-paced and adjusted to a dosage setpoint to achieve adequate ozone quenching in the ozone contactor cell as measured with contactor's Cell 6 dissolved ozone analyzer.

.2 Flow pacing shall be achieved through the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters (Qtotal) divided by the number of ozone contactors online. It is assumed that the flow from the DAF units is split equally between the Ozone contactors No. 1 and No. 2.

.3 The SBS dose is calculated by multiplying the SBS dosage ratio by the measured ozone residual. The default dosage ratio is 2.2 mg/L of SBS per mg of applied ozone, and can be adjusted by the operator

.6 Each pump Manufacturer shall supply and install all wiring and conduit within a skid package. Cables between skids shall be supplied and installed by Division 16.

.1 Control Panels to also comply with Section 17110.

.2 Motors to also comply with Section 11301.

1.3 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings, or request a deviation for approved equal at Shop Drawing submittal for Manufacturer's standard coating.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be by the Contractor in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

.2 Connect suction and discharge piping without imposing strain to pump flanges.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901, Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Flow Output: Measured by WTP instrumentation and storage volumes.

.3 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of days	For m
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer’s Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer’s Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

1.4 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Hydrogen Peroxide Pumps: P-C840A, P-C850A, P-C860A.

.2 Sodium Bisulphite Pumps: P-C950A, P-C960A, P-C970A.

END OF SECTION

SUPPLEMENT 1 – HYDROGEN PEROXIDE GEAR PUMPS

PARAMETER	VALUE
Tag No. (s)	P-C840A, P-C850A, P-C860A
Minimum Volumetric Flow Rate (litres/hour)	2.15
Maximum Volumetric Flow Rate (litres/hour)	38.6
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	30
Minimum Pump Flow Turndown Ratio	18:1
Pump Operation Duration (h/d)	24
Flow Operating Range (L/day)	50 - 925
Fluid Temperature Operating Range (◦C)	0.5 - 25
Solids Concentration Operating Range (%)	N/A
Commodity	Hydrogen Peroxide
Specific Gravity	1.13
Solids Concentration Range (%)	N/A
Driver Maximum (kW)	fractional
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max)	N/A
Motor Suitable for Variable Frequency Drive	Yes
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturers	Micropump Tuthill Approved equal

N/A – not applicable.

SUPPLEMENT 2 – SODIUM BISULPHITE GEAR PUMPS

PARAMETER	VALUE
Tag No. (s)	P-C950A, P-C960A, P-C970A
Minimum Volumetric Flow Rate (litres/hour)	0.5
Maximum Volumetric Flow Rate (litres/hour)	36.9
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	30
Minimum Pump Flow Turndown Ratio	80:1
Pump Operation Duration (h/d)	24
Flow Operating Range (L/day)	12 - 885
Fluid Temperature Operating Range (◦C)	0.5 - 25
Solids Concentration Operating Range (%)	N/A
Commodity	Sodium Bisulphite
Specific Gravity	1.33
Solids Concentration Range (%)	N/A
Driver Maximum (kW)	fractional
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max)	N/A
Motor Suitable for Variable Frequency Drive	Yes
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturers	Micropump Tuthill Approved equal

N/A – not applicable.

HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American Society for Testing and Materials (ASTM):

.1 A48, Gray Iron Castings.

.2 A576, Steel Bars, Carbon, Hot-Wrought, Special Quality.

.3 B62, Composition Bronze or Ounce Metal Castings.

.4 B148, Aluminum-Bronze Sand.

.5 B584, Copper Alloy Sand Castings for General Applications.

.2 American Iron and Steel Institute (AISI):

.1 Type 416 Stainless Steel.

.2 Type 1035 Steel.

.3 Type 4140 Alloy Steel.

.3 National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

.4 American Standards Association (ASA)

.1 B16.1 for Class 125 flanges

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to Section 11300 – Process Pumps General Requirements, and ratings and nomenclature of the Hydraulic Institute Standards.

1.3 Submittals

.1 Shop Drawings as per Section 01300 – Submittals:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

.5 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the design points, head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

.6 Detailed mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.7 Power and control wiring diagrams, including terminals and numbers.

.8 Complete motor nameplate data, as required by NEMA, motor Manufacturer, and including any motor modifications.

.9 Factory finish system.

.10 Provide certified shop test results for pump and motor assembly vibration levels at design operating point.

.2 Quality Control Submittals:

.1 Factory and field performance test reports and log.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions, including pump specific vibration and alignment tolerances.

.5 Certificates for delivery, installation and performance testing with forms as per Section 01650 – Equipment Installation**.**

.6 Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.7 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.8 Provide an operation and maintenance manual and maintenance summary in conformance with the requirements of Division 1, General Requirements, and Section 01730 - Operation and Maintenance Manuals**.**

.9 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.10 External utility requirements: air, water, power etc. for each component.

1.2 Extra Materials

.1 Furnish for each size of pumps:

.1 Complete set bearings.

.2 Complete set gaskets and O-ring seals.

.3 Complete set of shaft sleeves.

.4 Complete set keys, dowels, pins, etc.

.5 Complete mechanical seal.

.6 Impeller wear ring.

.7 One complete set of any special tools required to dismantle pump.

2. PRODUCTS

2.1 General

.1 Refer to Section 11000 – Equipment General Provisions, Section 11300 - Process Pump General Requirements, Section 11301 – Process Motors, and Section 16815 – Variable Frequency Drives.

.2 Coordinate pump requirements with drive Manufacturer and be responsible for pump and drive requirements.

.3 Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

.4 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications and contract drawings before including the price in their bid.

.5 The supply of horizontal split-case centrifugal pumps under this Section shall come from a single Manufacturer.

2.2 Pump Design

.1 Design the cast iron casing so that the impeller assembly and rings may be withdrawn and all passages and working parts readily accessible for the purpose of inspection,

repair, or removal of the rotating element without disturbing any of the piping system. Grind smooth the interior surfaces of the pump casing.

.2 Flange the suction and discharge nozzles of the pump casing in accordance with current ASA Specification B16.1 for Class 125 flanges.

.3 Provide a standard bronze impeller of the enclosed type, firmly keyed to the shaft and statically and dynamically balanced for the speed range at which it will be operated.

.4 Provide removable bronze wearing rings on impeller and casing, firmly held in place to prevent rotation or displacement. Accurately machine the wearing rings all over for minimum running clearance to reduce leakage. Install the rings in such a way that they can be removed without difficulty.

.5 The 416 stainless steel pump shaft shall be ground and polished all over and of ample size to prevent undue deflection or whip under all starting and running conditions.

.6 Provide a mechanically flexible coupling to connect the pump shaft to the drive motor shaft. The coupling shall be a flexible cone ring. For alignment, allow for the possibility of the pump to be at lowest water temperature (1 degree Celsius) and the motor at rated operating temperature.

.7 Provide anti-friction type ball or roller bearings of substantial proportions for continuous operation without overheating. Provide the pump with thrust bearings of approved design. Provide bearings with a B-10 rating of at least 100,000 hours as set out by the Anti-Friction Bearing Manufacturers' Association.

.8 Provide the pump with suitable tapped bonnet openings of ample size for vacuum priming, air relief, water seal and drainage pipe connections. Provide gauge connections tapped for 6 mm pipe on the suction and discharge nozzles close to the flanges at the horizontal centre line. The vacuum priming and air relief taps are to be 50 mm diameter.

.9 Provide single balanced, split mechanical seals as per Section 11300 – Process Pump General Requirements, Section 2.3 - Pump seals.

.10 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

.11 Provide drip containment pans under all gear mechanisms.

.12 Provide inverter duty rated motor for VFD service as per Section 11301 – Process Motors.

.13 Provide a pump/motor combination with a maximum length of 3700 mm that meets the clearances as indicated in contract drawings.

2.3 Baseplate

.1 Mount equipment and driver on a common baseplate in a compact arrangement.

.2 Provide equipment baseplates of heavy cast iron or of welded structural steel section at least 13 mm thick. Provide mounting plates at least 20 mm thick for mounting equipment and driver. Machine surfaces for mounting equipment and driver to an arithmetical average roughness height of less than 3 microns.

.3 Provide closed baseplates suitable for grouting. Provide grout holes, vent holes and anchor bolt holes in the baseplates.

.4 For equipment where leakage or condensation may occur provide baseplates with a drip lip and drain connections to the exterior of the base. Bossed connections to drip lips shall be below the gutter invert and shall be at least, 25 mm N.P.T. Provide piping from the drain connections to the building drainage system.

.5 Provide jack bolts with fine thread to allow two directional horizontal movement of the motor for realignment purposes.

.6 Provide 316 stainless steel anchor bolts for concrete base with dimensions designed and specified by Manufacturer to restrain the pump from movement and meet vibration tolerances. Provide pipe sleeves for anchor bolts not less than 2 1/2 times the diameter of the anchor bolts.

2.4 Supplements

.1 Pump data sheets and any other specific requirements are attached to this Section as supplements.

2.5 Accessories

.1 Equipment Identification Plate: 1.6 mm stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kg.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment Manufacturer.

.4 Non-ferrous Grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, Grace In-Pakt Grout, minimum compressive strength 35 MPa.

2.6 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings.

2.7 Source Quality Control

.1 Factory Tests and Adjustments: Test all equipment furnished as described in this section and Section 11300 – Process Pump General Requirements.

.2 Factory Test Report: Include test data sheets, curve test results, and performance test logs.

.3 Functional Test: Perform Manufacturer's standard, motor test on equipment. Include vibration test, as follows:

.1 Dynamically balance rotating parts of each pump and its driving unit before final assembly.

.2 Limits:

.1 Driving Unit Alone: Less than 80 percent of NEMA MG 1 limits.

.2 Complete Rotating Assembly Including: Coupling, Drive Unit, and Motor: Less than 90 percent of limits established in the Hydraulic Institute Standards and less than Manufacturer’s recommended tolerance.

.4 Performance Test:

.1 Provide pump curve in advance to ensure pump is properly sized.

.2 Conduct on each pump.

.3 Perform under simulated operating conditions at low and high flows as per pump data sheets.

.4 Test for a continuous 3-hour period without malfunction.

.5 Test Log: Record the following:

.1 Total head.

.2 Capacity.

.3 Power requirements.

.4 Flow measured by factory instrumentation and storage volumes.

.5 Average distance from suction well water surface to pump discharge centerline for duration of test.

.6 Pump discharge pressure converted to metres of liquid pumped and corrected to pump discharge centerline.

.7 Calculated velocity head at the discharge flange.

.8 Field head.

.9 Driving motor voltage and amperage measured for each phase.

.6 Duration of hydrostatic test shall be one hour minimum. Adjust, realign, or modify units and retest in accordance with Hydraulic Institute Standards if necessary.

.5 Motor Test: See Section 11301 – Process Motors, requirements for AC Induction Motors.

.6 Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation shall be by the Contractor in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.2 Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 6 mm per 0.3 m. Use double wedges to provide a level bearing surface for the pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

.3 Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

.4 After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout. Remove wedges after grout is set and pack void with grout.

.5 Connect suction and discharge piping without imposing strain to pump flanges.

.6 Anchor Bolts: Accurately place using equipment templates. All mounting brackets, bases, beams, hardware and stabilizers shall be Type 316 stainless steel and shall be supplied by the Manufacturer.

.7 Pipe pump drain(s) to hub drain or gutter drain.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.2 mm or velocities in excess of 6 mm/sec.

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Flow Output: Measured by plant instrumentation and storage volumes.

.4 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table, along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer’s Representative shall ensure that each pump, including all component parts, operates as intended at all design points noted in the Supplements for the duration of normal operating cycles.

.2 The Manufacturer’s Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation and Section 01664 - Training.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Backwash Supply Pumps: P-F911A, P-F921A.

.2 Flash Mix Pumps:P-I013, P-I014, P-I015.

END OF SECTION

SUPPLEMENT 1 – BACKWASH SUPPLY (BWS) PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-F911A, P-F921A	
Design Point Flow Capacity (cubic metres/day)	Primary 102,000	Secondary 76,000
	Tertiary 28,000	Minimum 19,000
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	Primary 14.0	Secondary 12.0
	Tertiary 9.5	Minimum 9.0
Net Positive Suction Head Available(NPSHA) (Head (m) at Design Flow)	7.0	
Flow Operating Range (cubic metres/day)	19,000-102,000	
Total Dynamic Head (TDH) Operating Range (m)	9.0-14.0	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	N/A	
Minimum Suction Water Elevation (Geodetic) (m)	231.000	
Pump Room Finished Floor (Geodetic) (m)	230.250	
Centreline Pump Discharge (Geodetic) (m)	231.400	
Driver Maximum (kW)	224	
Driver Voltage (V/phase/frequency)	575/3/60	
Speed (max) (rpm)	1200	
Motor Suitable for Variable Frequency Drive	Yes	
Minimum Pump Efficiency at Design Point (%)	80%	
Maximum length, pump centre to motor end (mm)	2900	
Pump Suction and Discharge flange size basis (mm)	600 x 500	
Acceptable Manufacturers	ITT Allis-Chalmers Flowserve KSB	

N/A – not applicable.

SUPPLEMENT 2 – FLASH MIX PUMPS

PARAMETER	VALUE
Tag No. (s)	P-I013A, P-I014A, P-I015A
Location	DAF Influent Gallery
Design Point Flow Capacity (litres/second)	75
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	11.7
Net Positive Suction Head Available (NPSHA) (Head (m) at Design Flow)	22
Flow Operating Range (litres/second)	75
Total Dynamic Head (TDH) Operating Range (m)	11.7
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Minimum Suction Water Elevation (Geodetic) (m)	243.00 (1)
Pump Room Finished Floor (Geodetic) (m)	233.17
Centreline Pump Discharge (Geodetic) (m)	233.680
Driver Maximum (kW)	11.25
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max), (rpm)	1750
Motor Suitable for Variable Frequency Drive	No
Minimum Pump Efficiency at Design Point (%)	80
Acceptable Manufacturers	ITT Allis-Chalmers Flowserve KSB

N/A – not applicable.

(1) Pumps draw from pressurized header and discharge downstream into pressurized header at same elevation. Headlosses are mainly due to losses through discharge nozzle into main header.

SAMPLING PUMPS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American Bearing Manufacturers' Association (ABMA).

.2 National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to Section 11300 – Process Pumps General Requirements, and ratings and nomenclature of the Hydraulic Institute Standards.

1.3 Contractor Submittals

.1 Shop Drawings:

.1 Make, model, weight, horsepower, and cross sectional details and colour brochures of each equipment assembly.

.2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

.4 Detailed Drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.5 Power and control wiring diagrams.

.6 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.

.7 Factory finish system.

.8 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.9 External utility requirements air, water, power, etc for each component.

.10 Control Panel external face layout and inter layout drawings and electrical wiring diagrams.

.2 Quality Control Submittals:

.1 Factory Functional and Performance Test Reports.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Suggested spare parts list to maintain the equipment in service for a period of five (5) years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Operation and maintenance (O&M) manual.

1.4 Responsibility of the Pump Manufacturer

.1 The pump Manufacturer is responsible for the selection, co-ordination and performance of the metering pumps, motors, and control stations which will be capable of meeting the head, pressure, accuracy and flow requirements specified herein. The pump Manufacturer is responsible for the selection, co-ordination and performance of the appurtenances.

.2 All major components (pumps and accessories) shall be supplied as a Vendor Package unless specified otherwise.

2. PRODUCTS

2.1 General

.2 Supplements at the end of this Section list Acceptable Manufacturers, and where specified models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid."

.3 The supply of sampling pumps under this Section shall come from a single Manufacturer.

SAMPLING PUMPS

2.2 Pumping Requirements

.1 Take into account the specific gravity, viscosity, corrosivity and temperature of the fluid being pumped.

.2 Minimum turn-down ratio: 1:2000

.3 Provide a minimum pumping accuracy of +2% of the full range for each pump package

2.3 Pumping Units

.1 Construct the pump parts in contact with the commodity being pumped from materials suitable for the application.

.2 The sampling pumps shall be the positive displacement, peristaltic type, self-priming unit. The pump shall consist of a spring loaded single pump head and flexible extruded tubing.

.3 Peristaltic pumping action shall be created by the compression of the flexible tube between the pump head rollers and track, inducing forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum-creating restitution of the tube. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components. Pumps shall be dry self priming, capable of being run dry without damaging effect to pump or tube.

.4 Pump head shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism. At all times, one roller shall be fully engaged with the tubing providing complete compression and preventing back flow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate tubing from 1.6mm to 9.6mm ID. Provide two spring–loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pump head. Pump heads requiring disassembly or special tools for tube changing are not considered equal.

.5 Clutch: Equip rotor with central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch to automatically re-engage rotor to gearbox upon one complete revolution.

.6 Provide 316L SST clamps for each tube connection

.7 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.4 Appurtenances

.1 For each pump, provide two complete sets of thermoplastic or 316L SST quick connect couplings. Materials to have excellent compatibility with commodity being used.

.1 Coupling Body: Shut-off type, 13mm MNPT fitting, for connection to permanent pump suction and discharge piping.

.2 Coupling Insert: Shut-off type, Hose barb fitting, sized to suit pump tubing.

.3 Hose Clamps: 316L SST

.4 Manufacturer: Omega FT-HFC Series, Parker, Swagelok or approved equal.

2.5 Pump Drive and Controls

.1 Equipment shall be CSA and ULC certified. Equipment and material to be CSA and ULC certified. Where there is no alternative to supplying equipment that is not CSA certified, obtain special approval from the Electrical Safety Authority.

2.6 Pump and Drive Unit

.1 Enclosure: NEMA 4X / IP66, Die cast, Polyester coated, corrosion resistant

.2 Operating Temperature: 0 to 40ºC

.3 Brushless DC motor, 100% Duty cycle, with integral gearbox and DC drive (turndown as required to suit pump capacity). The DC inverter shall be integral part (built-in) of the pump assembly. The controls shall include motor load compensation and protection.

.4 Speed Adjustment Range: 2200:1

.5 Speed Accuracy: 0.1% of Range

2.7 Control Signals to External PLC

.1 Start/Stop Control: 120VAC, 1 Phase internally supplied, suitable for control from remote PLC dry contact.

.2 Running Status: Form C, dry contact relay, rated 1A at 120 VAC

.3 Leak sensor: fault signal

2.8 Electrical:

.1 120 VAC, 15A, 1 Phase, 60 Hz, internally fused

.2 Each pump AC supply circuit to be provided with local, watertight, corrosion resistant, lockable disconnect switch, by Division 16 unless otherwise specified.

.3 Provide all other required Manufacturer's power and control cables c/w connectors.

2.9 Accessories

.1 Equipment Identification Plate: 16-gauge stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location.

2.10 Factory Finishing

.1 Manufacturer's standard finish.

2.11 Spare parts

.1 Submit a list of spare parts and specialty tools with prices and local representative phone number and addresses.

.2 As a minimum, supply:

.1 One spare pump head assembly and rotor per pump

.2 Supply three 15-meter continuous rolls of specified tubing size for each different chemical service

.3 Two spare sets of tubing quick disconnects per pump

.4 Two (2) extra rollers per pump

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be by the Contractor in accordance with the Manufacturer's printed installation instructions.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Flow Output: Measured by WTP instrumentation and storage volumes.

.3 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	1	102
4	Assistance in Equipment Performance Testing	1	103
5	Operator and Maintenance Training	1	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Residuals Area Sample Pump: SP-R010A

.2 Clearwell Area Sample Pumps: SP-T201A, SP-T101A

END OF SECTION

SAMPLING PUMPS

SUPPLEMENT 1 – RESIDUALS AREA SAMPLING PUMP

PARAMETER	VALUE
Tag No. (s)	SP –R010A
Minimum Pumping Rate (ml/min)	200
Maximum Pumping Rate (ml/min)	700
Backpressure (kPa)	NA
Minimum Pump Flow Turndown Ratio	N/A
Flow Operating Range (L/day)	See above
Pump Operation Duration (h/d)	5-7 (Intermittent)
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	0-0.005
Commodity Pumped	Supernatant (SUP)
Specific Gravity	1.00
Driver Maximum (kW)	fractional
Driver Voltage (V/phase/frequency)	120/1/60
Speed (max)	N/A
Pump Speed Adjustment Range	2200:1
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturer	Watson-Marlow Bredel SPX15 Series Verderflex, Series VF15 Approved equal

N/A – not applicable.

Note: Hydraulic and other specified requirements: refer to and provide pump curves and pump data sheets for sizing and selection of pumps, motors and other components.

SUPPLEMENT 2 – CLEARWELL AREA SAMPLING PUMPS

PARAMETER	VALUE
Tag No. (s)	SP-T201A, SP-T101A
Minimum Pumping Rate (ml/min)	500
Maximum Pumping Rate (ml/min)	5,000
Backpressure (kPa)	NA
Minimum Pump Flow Turndown Ratio	N/A
Flow Operating Range (L/day)	See above
Pump Operation Duration (h/d)	24 (Continuous)
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Commodity Pumped	Treated Water (TW)
Specific Gravity	1.00
Driver Maximum (kW)	fractional
Driver Voltage (V/phase/frequency)	120/1/60
Speed (max)	N/A
Pump Speed Adjustment Range	2200:1
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturer	Watson-Marlow Bredel SPX15 Series Verderflex, Series VF15 Approved equal

N/A – not applicable.

Note: Hydraulic and other specified requirements: refer to and provide pump curves and pump data sheets for sizing and selection of pumps, motors and other components.

VERTICAL TURBINE PUMPS

1. GENERAL

1.1 Work Included

.1 Supply, installation, and performance verification of vertical turbine pumps.

1.2 Submissions

.1 Shop Drawings: Submit in accordance with Section 01300 – Submittals and 11300 – Process Pumps General Requirements:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand and overall efficiency required at guarantee point.

.4 Power and control wiring diagrams, including terminals and numbers.

.5 Complete motor nameplate data, as defined by NEMA, from motor manufacturer.

.6 Factory finish system.

.7 Bearing life calculations.

.2 Quality Control Submittals:

.1 Factory and Field Performance Test Reports and Log.

.2 Manufacturer's Certification of Compliance that factory finish system meets requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Certificates for delivery, installation and performance testing with forms as per Section 01650 – Equipment Installation.

.6 Suggested spare parts list to maintain equipment in service for period of one (1) year and five (5) years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.7 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.8 O&M manual.

1.3 Delivery and Storage

.1 Ship pre-assembled as far as possible to enable easy installation.

1.4 General Equipment Stipulation

.1 Supplements at the end of this Section list approved Manufacturer's and where specified models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these Specifications, and that fit within the piping and equipment layout shown in the Contract Drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the Specifications before including the price in their bid.

.2 The supply of equipment under this Section shall come from a single Manufacturer.

2. PRODUCTS

2.1 Description

.1 Use these pumps for the pumping of supernatant from the wastewater recovery tanks (used for filter backwash solids settling). Thickened sludge supernatant and miscellaneous flows.

2.2 Pump Schedule

.1 Specific pumps to be supplied are listed in the schedules contained at the end of this Section. The supply of vertical turbine pumps shall come from only one (1) single Manufacturer.

2.3 Pump Performance

.1 The pump performance shall be as scheduled. The pump head/discharge characteristic shall provide a continuously falling curve throughout the pump range from shut off to run out so that only one (1) flow rate is possible for a specific total discharge head.

2.4 Pump Setting

.1 The Contractor shall ascertain and confirm the exact pump setting length, which shall also comply with the general details shown on the drawings.

.2 The clearance between underside of the pump bell and the sump floor or bottom of the enclosing can shall conform to the manufacturer's recommendation.

2.5 Column

.1 The discharge column shall form a connection between the discharge elbow and bowl assembly.

.2 The discharge column setting length shall be such as to provide the pump Manufacturer's recommended optional setting between the bottom of the suction bell and the sump floor.

.3 The discharge column shall be flanged connection. Maximum section length for column shall be 1525 mm.

.4 Column material shall be:

.1 Column: Steel ASTM A53, Grade B, Schedule 40.

.2 Bolts and Fixings: AISI 316, Type 18-8, Stainless Steel.

.5 Column wall thickness shall be suitable to support all pump loads and internal pressures.

.6 Flanged column connections shall incorporate a rabbet fit to ensure correct alignment.

.7 Column pipe shall be epoxy-coated internally and externally in accordance with AWWA D102-78, System 1, minimum dry film thickness of 300 µ and two coats.

2.6 Lineshaft

.1 The lineshaft shall be of the open type.

.2 Open lineshafts shall be supported by product lubricated bearings (self lubricated graphalloy).

.3 Lineshaft materials shall be 316 stainless steel with not less than 12% chrome content. The shaft size, machining tolerances, and straightness shall comply with AWWA E101-77, Section 4.3. The lineshaft surface shall be precision-turned, ground, and polished.

.4 The lineshaft shall be provided in the maximum section lengths of 1525 mm. Sections shall be interchangeable. Lineshaft couplings shall be of identical material to the line shaft and shall ensure the tight butting of adjacent sections. Couplings shall be threaded.

2.7 Lineshaft Bearings

.1 Bearings shall be lubricated by the pumped fluid.

.2 Bearings shall be of abrasion-resistant rubber and bronze construction where continually submerged during operation of the pump.

.3 Self-lubricated graphalloy bearings shall be used where bearings are not continually submerged during operation of the pump.

.4 Bearings shall be secured by stainless steel retaining pins, press fit or lock nuts and anti-rotation pins.

2.8 Stuffing Box

.1 For each vertical turbine pump, a stuffing box with five (5) rows of packing shall be provided.

2.9 Suction Bell

.1 Each pump shall be fitted with a steel or cast iron suction bell.

.2 The suction bell shall incorporate vanes to support the bottom bearing housing.

.3 The suction bell inlet velocity shall not exceed 1.5 m/s.

.4 Internal and external surfaces shall be epoxy-coated in accordance with AWWA D102-78 system. Minimum dry film thickness of 300 µ, two coats.

2.10 Pump Bowl Cases

.1 The pump bowl cases shall incorporate bolted connections.

.2 Pump bowl cases shall be designed for an internal pressure exceeding either 2.0 times the pumpset maximum design head or 1.5 times the pumpset shut-off head, whichever is the greater.

.3 Materials shall be:

.1 Bowl case: cast iron, ASTM A48 Clause 30 or better.

.2 Bolts and nuts: stainless steel, A151 416, Type 18-8.

.4 Internal and external surfaces shall be epoxy-coated in accordance with AWWA D102-78, System 1, minimum dry film thickener of 300 µ, two coats.

2.11 Pump Bowl Shaft

.1 The pump bowl shaft shall be supported by bearings above and below the impeller.

.2 Shaft material shall be 416 stainless steel, heat treated with a Brinel hardness number of 450. The shaft shall be precision-turned, ground, and polished.

.3 The shaft size, machining tolerances and straightness shall comply with AWWA E101-77, Section A4.3.

2.12 Bottom Bearings

.1 A bottom bearing assembly shall be provided within the suction bell.

.2 The bottom bearing shall be a bronze, plain or flanged sleeve type and shall be fully enclosed in a bearing shell.

.3 The bearing shall be permanently lubricated using a non-soluble grease.

.4 AFBMA-B10 bearing life shall be 40,000 hours.

2.13 Bowl Bearing

.1 Each bowl or pump stage shall incorporate a sleeve type bearing. The bearing shall be designed to assure stable operation away from critical speed.

.2 The bearings shall be of abrasion-resistant rubber and bronze construction.

.3 The bearings shall be designed for lubrication by the pumped fluid.

.4 Each bowl shall provide a side and bottom seal at the impeller skirt to prevent slippage of water between the bowl and impeller.

2.14 Impellers

.1 Impellers shall be of the fully enclosed or semi-open type.

.2 The impellers shall be carefully machined and polished, and shall be both statically and dynamically balanced.

.3 Impellers shall be securely fastened to the impeller shaft with a tapered bushing.

.4 Impellers shall be of all bronze construction to ASTM B145-70 Alloy 836 or superior material.

.5 Vertical adjustment of the impeller shall be provided by means of a top shaft nut above the top lineshaft seal.

2.15 Discharge Head

.1 A pump discharge head of high grade cast iron or fabricated steel shall be provided.

.2 The discharge head shall be suitable for either above ground or below ground discharge as scheduled. Above ground discharge heads shall incorporate a motor-mounting flange.

.3 The discharge head shall be provided with a flanged discharge connection of rating and diameter as scheduled.

.4 The pump discharge head internal surfaces shall be epoxy coated in accordance with AWWA D107-78, system 1, minimum dry film thickness of 300 μ, two coats. The external surfaces shall have the same coating system as the pump discharge piping.

2.16 Gauge Connections

.1 Provide tapped and plugged suction and discharge pressure gauge connections on the pump nozzles or flanges. Where this is not possible, provide gauge connections on the immediately adjacent piping.

2.17 Foundation Plate

.1 A steel pump foundation plate shall be provided to support the discharge head assembly. The top surface shall be accurately machined to match the bottom flange of the discharge head.

.2 The foundation plate shall be of sufficient size to support all pump loads and to span the openings provided for pump column removal. The opening size shall be sufficient to pass all pump bowl or column components.

.3 The mounting bolt holes shall be provided and tapped to match the discharge head bottom flange.

2.18 Driver

.1 The electric motor drivers shall conform to the requirements of Section 11301 – Process Motors and the attached Detailed Pump Specification Sheet. Motors shall be of high efficiency and shall meet the Manitoba Hydro's minimum requirements for eligibility for motor capital cost rebate.

2.19 Spare Parts

.1 Provide one spare impellar, complete set of seals, gaskets, O-rings, set keys, dowels, pins, for each pump and any special tools required to dismantle the pump.

3. EXECUTION

3.1 Installation by Installation Contractor

.1 Installation will be in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Connect suction and discharge piping without imposing strain to pump flanges.

3.2 Finishing

.1 All components shall be epoxy coated as per the Manufacturer's specifications and Section 11901 – Factory Applied Protective Coatings, unless specified otherwise.

.2 Painting and finishing shall be in accordance with Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Field Quality Control

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.1 mm or velocities in excess of 3 mm/sec.

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Flow Output: Measured by plant instrumentation and storage volumes.

.4 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with the latest version of HIS and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct installer in the methods and precautions to be followed in the installation of the equipment. Certify the Installation Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips. A "day" is defined as eight (8) working hours On-Site.

.4 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation Work, certify correct installation, train O&M staff and undertake the

testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of days	Form
1	Equipment Delivery	1	100
2	Installation Assistance (combined with Equipment Delivery Trip)	1	101
3	Witnessing of Equipment Installation	1	102
4	Assistance in Equipment Performance Testing (combined with Item 3)	4	103
5	Operator and Maintenance Training	2	T1

3.5 Installation Witnessing

.1 The Installation Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Installation Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Installation Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

.4 Refer to Section 11300 – Process Pumps General Requirements for testing requirements.

3.7 Process Performance Testing

.1 The Manufacturer's Representative shall attend during commissioning period to ensure the equipment functions as intended in the process system as documented by Form 104.

Provide assistance as required for system programming, startup and troubleshooting. Conform to the requirements of Section 01650 – Equipment Installation.

.2 Refer to Section 11300 – Process Pumps General Requirements for testing requirements.

.3 Events that qualify as unsuccessful and incomplete Process Performance Verification include, but are not necessarily limited to, the following:

.1 Splashing, leaking or dripping.

.2 Operational, mechanical or performance deficiency noted by the Contract Administrator as an event representing unsuccessful Equipment Performance Testing.

.3 Failing to meet the designed performance curve of the pumps.

3.8 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper O&M of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.9 Supplements

.1 The supplements attached to this Section are part of this Specification.

.2 Data Sheet:

.1 Supplement 1 Supernatant Pumps: P-R021, P-R022, P-R023.

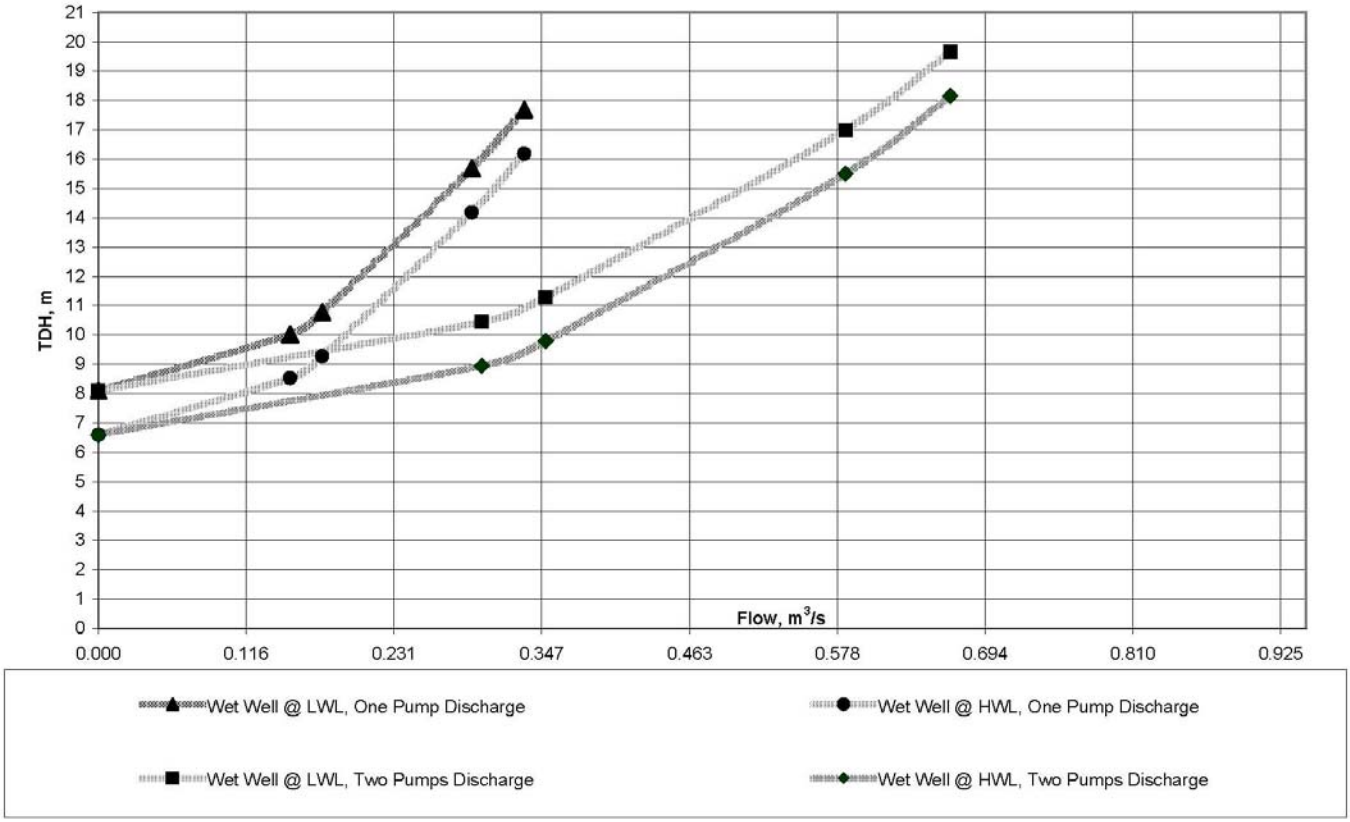
.2 Supplement 2 Supernatant Pumps: System Curve.

END OF SECTION

SUPPLEMENT 1 – SUPERNATANT PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-R021, P-R022,P-R023	
Location	Inside / Non-Hazardous Area	
Type of Installation:	Vertical Turbine	
Design Point Flow Capacity (L/s)	Primary : 292	Secondary: 570
Design Point TDH (m) (excludes losses internal to pump)	Primary : 14.2	Secondary: 17
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	292-570	
TDH Operating Range (m)	14.2 - 15	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	0.01 to 0.06	
Minimum Suction Water Elevation (Geodetic) (m)	232.75	
Maximum Suction Water Elevation (Geodetic) (m)	237.61	
Pump Room Finished Floor (Geodetic) (m)	239.41	
Centreline Pump Discharge (Geodetic) (m)	239.87	
Driver Maximum (kW)	75	
Driver Voltage (V/phase/frequency)	575/3/60	
Enclosure	TEFC	
Speed (max)	1185 rpm	
Motor Suitable for VSD	Yes	
Minimum Pump Efficiency at Design Point (%)	80	
Design Standard	Flowserve	
Acceptable Manufacturer’s	Flowserve, Ebara, Fairbanks, Morse, Peerless, Patterson	

SUPPLEMENT 2 – SUPERNATANT PUMP SYSTEM CURVES



HORIZONTAL, SCREW IMPELLER PUMPS

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation, testing, and performance verification of horizontally mounted, screw impeller, centrifugal pumps.

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of HIS.

1.3 Submittals

.1 Shop Drawings: Submit in accordance with Section 01300 – Submittals and Section 11300 – Process Pumps General Requirements:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand and overall efficiency required at guarantee point.

.4 Power and control wiring diagrams, including terminals and numbers.

.5 Complete motor nameplate data, as required by NEMA, from motor Manufacturer.

.6 Factory finish system.

.7 Bearing life calculations.

.2 Quality Control Submittals:

.1 Factory and Field Performance Test Reports and Log.

.2 Manufacturer's assurance that factory finish system meets requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Suggested spare parts list to maintain equipment in service for period of one (1) year and five (5) years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 O&M Manual.

2. PRODUCTS

2.1 General

.1 Supplements at the end of this Section list approved Manufacturers, and where specified models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the Contract Drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the Specifications before including the price in their bid

.2 The supply of horizontal screw impeller pumps under this Section shall come from a single Manufacturer

2.2 Description

.1 Use these pumps for the pump DAF float (sludge). The sludge has a TSS concentration less than 30,000 mg/L, with minimal abrasive material.

2.3 Supplements

.1 Pump data sheets and any other specific requirements are attached to this Section as supplements.

2.4 Materials

.1 Fabricate impeller of hardened high chrome iron, ASTM A532 Cl III, Type A1, with minimum Brinell hardness of 450.

.2 Fabricate casing of cast iron, ASTM A48, with no less than 3% nickel.

.3 Fabricate suction liner of Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinell hardness of 450.

.4 Fabricate shaft of steel, ASTM A108, Grade 1141 or 1045.

.5 Fabricate shaft sleeve of stainless steel, ASTM A276, Type 416 or 420, with minimum Brinell hardness of 450.

.6 Manufacture pump bases of cast iron or fabricated steel.

2.5 Impellers

.1 Provide spiral screw type impeller combining the action of positive displacement screw and a single vane centrifugal impeller.

.2 Provide conical geometry of the impeller and suction pieces to maintain optimum running clearances along the entire length of the impeller.

.3 Statically and dynamically balance impellers.

.4 Secure impeller to shaft with an impeller bolt, formed to shed stringy material.

2.6 Casings

.1 Provide casings of two piece construction consisting of volute and suction cone, with an end suction and that discharge vertically upwards.

.2 Provide suction cone internal profile with a straight sided cone to allow axial adjustment to maintain running clearances between the impeller and suction cones.

.3 Provide back pull out design to permit withdrawal of the impeller without disturbing the discharge or suction piping.

.4 Provide self-centering backhead and with back pull-out.

.5 Provide casing with a tapped and plugged connection at the discharge nozzle for a pressure gauge, a vent on top of the case, and a drain on the bottom of the case.

.6 Design the casing so that it is capable of passing solid spheres of the following sizes:

.1 100 mm or less casing connections: 50 mm sphere

.2 150 mm casing connections: 75 mm sphere

.3 Greater than 150 mm casing connections: 100 mm sphere

.7 Pressure test casings at 1.5 times the pressure developed by the pump at shut off head.

.8 Solidly foot-mount casings to allow easy access to pump interior.

.9 Provide suction and discharge connections that are flanged, faced, and drilled to conform to ASTM B16.5, Class 125.

2.7 Inlet Nozzle

.1 Provide inlet nozzle with an eccentric reduction to the connection at the casing.

.2 The top of the nozzle is horizontal and parallel to the pump shaft with no pockets or discontinuities which might trap air.

2.8 Suction Liner

.1 To facilitate adjustment of clearances between the suction cone and impeller, provide replaceable and externally adjustable suction liner.

.2 Provide adjustment for the suction liner by means of not more than three (3) external screws, located equidistant around the circumference of the suction cone. The use of shims shall be acceptable for only the smallest pumps.

.3 Ensure adjusting screws are capable of advancing or retracting the suction liner and are capable of locking the position of the suction liner.

2.9 Cleanouts

.1 Supply each pump with a hand sized cleanout either integral with the casing or on a suction spool piece attached to the casing.

2.10 Shafts

.1 Fit to impeller with impeller key.

.2 Make the shaft of sufficient diameter to assure rigid support of the impeller and to transmit loads without slip, vibration or undue deflection at operating loads. Where L = impeller overhang and D = shaft diameter, maintain $L^3/D^4<80$.

.3 Provide shaft manufactured of heat-treated high strength steel, turned, ground and polished of proportions suitable for use in constant speed or variable speed pumping applications.

.4 Provide reduced diameter section for sleeves.

.5 Each shaft is of sufficient section to limit deflection at the outer seal face to not more than 0.10 mm when pump is operating at continuous duty point defined by the operating conditions.

2.11 Seals

.1 Design Standard

.1 Provide a tandem mechanical seal with oil bath (no external flush required). For tandem mechanical seal, indicate whether seal housing can accommodate a standard John Crane Type 1 inboard (process side) seal in the future without machining the seal housing. Single mechanical seals with a lip seal to hold the oil from leaking around the shaft, are not acceptable.

.2 The inboard seal (in the process fluid) is to have a protective cover around the spring or some means to prevent solids from accumulating in the spring. A John Crane Type 5611Q seal is not specifically required but materials are to match those specified in Section 11300 – Process Pumps General Requirements. Provide a 316L stainless steel tubing or pipe from the pump discharge to the seal to allow for a process fluid flush (i.e., internal flush), similar to API Seal Flush Plan 11. Piping size is to be determined by the pump manufacturer but shall include either an orifice (minimum 6 mm diameter) or a "choke tube" of 6 mm diameter or greater to allow for flow control.

.2 Alternative

.1 Alternatively, provide a cartridge type, single mechanical seal with an external flush connection. Contractor to include Standard Detail STD-2 (on drawing WB-M0464) at each pump, include a seal water isolation valve, check valve, solenoid valve, seal water flow element and low flow switch and timer. Low flow setpoint by pump/seal manufacturer. Coordinate with Division 15 for plant service water (PSW) piping to the seals and Division 17 for incorporation of the low flow switches to the PCS. On pump start, seal water solenoid valve is opened and timer K starts timing. While pump is running and K>10 seconds, if FLS= Low them send pump low seal water flow alarm to PCS and switch to standby pump. On pump stop, seal water solenoid valve is closed and timer K is reset. Pump low seal water flow alarm is reset when pump starts.

.2 Refer to Section 11300 – Process Pumps General Requirements for seal materials of constructions.

2.12 Bearings

.1 Oil or grease lubricated duplex thrust angular contact and roller bearings.

.2 Minimum B-10 life of 40,000 hours at maximum efficiency as specified in Section 11000 – Equipment General Provisions.

.3 Design radial and thrust bearings for the worst combination of loading developed at all operating conditions for a bearing life of 40,000 hours.

2.13 Motors

.1 Motor types, voltages, service conditions and power ratings are indicated in the detailed pump specification sheets.

.2 Provide motors that comply with the provisions of Section 11301 – Process Motors.

2.14 Bases

.1 Provide bases with grouting holes, a minimum of one at the centre and one at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.2 Ensure bases have square corners in all three directions, with parallel surfaces.

.3 Provide motor mounting blocks so that one size greater motor frame may be accommodated by replacing the mounting blocks.

.4 Provide drip containment pans under all gear mechanisms.

2.15 Accessories

.1 Equipment Identification Plate: 1.6 mm stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kg.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

.4 Non-ferrous Grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, Grace In-Pakt Grout, minimum compressive strength 35 MPa.

2.16 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Maintenance and Protection Coatings.

2.17 Source Quality Control

.1 Pump:

.1 Factory Performance Test:

.1 In accordance with HIS pump tests.

.2 Include test data sheets, curve test results, performance test logs.

.2 Conduct on each pump.

.3 Perform under actual or approved simulated operating conditions.

.1 Throttle discharge valve to obtain pump data points on curve at 2/3, 1/3, and shutoff conditions.

.2 Motor Functional Test: Perform Manufacturer's standard motor test. Run for 30 minutes at pumping conditions corresponding to maximum motor load. See Section 11301 – Process Motors requirements for AC Induction Motors.

.3 Hydrostatic Tests: Pump casing(s) tested at 150% of shutoff head. Test pressure maintained for not less than 5 minutes.

2.18 Spare Parts

.1 Provide the following spare parts for each size of pump:

.1 One (1) bearing set per pump.

.2 One (1) seal set per pump.

.3 Two (2) suction cones for each size of pump.

.4 For each pump type and size, provide a single impeller wear plate suction ring (if replaceable), one pump shaft, and nut.

.5 One (1) complete set of special tools required to dismantle pump, if required.

3. EXECUTION

3.1 Installation

.1 Installation will be in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Level base by means of steel wedges (steel plates and steel shims). Wedge taper not greater than 6 mm per 0.3 m. Use double wedges to provide a level bearing surface for the pump and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

.2 Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

.3 After the pump and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, non-shrinking grout. Remove wedges after grout is set and pack void with grout.

.4 Connect suction and discharge piping without imposing strain to pump flanges.

.5 Anchor Bolts: Accurately place using equipment templates. All mounting brackets, bases, beams, hardware and stabilizers shall be Type 316 stainless steel and shall be supplied by the Manufacturer.

.6 Pipe pump drain(s) to hub drain or gutter drain.

3.2 Field Finishing

.1 Provide field finishing with touch ups for equipment as specified in Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Field Quality Control

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.1 mm or velocities in excess of 3 mm/sec.

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Flow Output: Measured by plant instrumentation and storage volumes.

.4 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with HIS and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Ensure the Contractor has been provided with the Manufacturer’s methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips.

.4 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation

work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of

the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below are a part of this Specification.

.2 Data Sheets:

.1 Float Sump Pumps: P-P931A, P-P932A, P-P941A, P-P942A, P-P951A, P-P952A, P-P961A, P-P962A

END OF SECTION

SUPPLEMENT 1 – FLOAT TRANSFER PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-P931A, P-P932A	
Location	DAF Pump Gallery Inside / Non-Hazardous Area	
Design Point Flow Capacity (L/s)	Primary :12.6	Secondary BM
		Max. Desired: 12.6
Design Point TDH (m) (excludes losses internal to pump)	Primary : 3.3	Secondary 5.7
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	N/A	
TDH Operating Range (m)	3.3 to 5.7	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	1.0 to 4.0	
Minimum Suction Water Elevation (Geodetic) (m)	236.9	
Pump Room Finished Floor (Geodetic) (m)	236.17	
Centreline Pump Discharge (Geodetic) (m)	236.67	
Driver Maximum (kW)	7.5	
Driver Type	Direct Coupled	
Driver Voltage (V/phase/frequency)	575/3/60	
Enclosure	TEFC	
Speed (max)	1750 rpm	
Motor Suitable for VFD	No	
Minimum Pump Efficiency at Design Point (%)	45	
Acceptable Manufacturers	Hayward Gordon ITT AC Wemco/Hidrostal	

N/A – Not Applicable.
BM – By Manufacturer
Manufacturer shall indicate flow at secondary TDH of 8.68 m in the submittal.

SUPPLEMENT 2 – FLOAT TRANSFER PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-P941A, P-P942A	
Location	DAF Pump Gallery Inside / Non-Hazardous Area	
Design Point Flow Capacity (L/s)	Primary :12.6	Secondary BM
		Max. Desired: 12.6
Design Point TDH (m) (excludes losses internal to pump)	Primary : 3.57	Secondary 5.97
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	N/A	
TDH Operating Range (m)	3.57 -	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	1.0 to 4.0	
Minimum Suction Water Elevation (Geodetic) (m)	236.9	
Pump Room Finished Floor (Geodetic) (m)	236.17	
Centreline Pump Discharge (Geodetic) (m)	236.67	
Driver Maximum (kW)	7.5	
Driver Type	Direct Coupled	
Driver Voltage (V/phase/frequency)	575/3/60	
Enclosure	TEFC	
Speed (max)	1750 rpm	
Motor Suitable for VFD	No	
Minimum Pump Efficiency at Design Point (%)	45	
Acceptable Manufacturers	Hayward Gordon ITT AC Wemco/Hidrostal	

N/A – Not Applicable.
BM – By Manufacturer
Manufacturer shall indicate flow at secondary TDH of 8.98 m in the submittal.

SUPPLEMENT 3 – FLOAT TRANSFER PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-P9351A, P-P952A	
Location	DAF Pump Gallery Inside / Non-Hazardous Area	
Design Point Flow Capacity (L/s)	Primary :12.6	Secondary BM
		Max. Desired: 12.6
Design Point TDH (m) (excludes losses internal to pump)	Primary : 4.25	Secondary 6.65
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	N/A	
TDH Operating Range (m)	4.25 – 6.65	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	1.0 to 4.0	
Minimum Suction Water Elevation (Geodetic) (m)	236.9	
Pump Room Finished Floor (Geodetic) (m)	236.17	
Centreline Pump Discharge (Geodetic) (m)	236.67	
Driver Maximum (kW)	7.5	
Driver Type	Direct Coupled	
Driver Voltage (V/phase/frequency)	575/3/60	
Enclosure	TEFC	
Speed (max)	1750 rpm	
Motor Suitable for VFD	No	
Minimum Pump Efficiency at Design Point (%)	45	
Acceptable Manufacturers	Hayward Gordon ITT AC Wemco/Hidrostal	

N/A – Not Applicable.
BM – By Manufacturer
Manufacturer shall indicate flow at secondary TDH of 9.66 m in the submittal.

SUPPLEMENT 4 – Float Transfer PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-P961A, P-P962A	
Location	DAF Pump Gallery Inside / Non-Hazardous Area	
Design Point Flow Capacity (L/s)	Primary :12.6	Secondary BM
		Max. Desired: 12.6
Design Point TDH (m) (excludes losses internal to pump)	Primary : 5.02	Secondary 7.42
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	N/A	
TDH Operating Range (m)	5.02-7.42	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	1.0 to 4.0	
Minimum Suction Water Elevation (Geodetic) (m)	236.9	
Pump Room Finished Floor (Geodetic) (m)	236.17	
Centreline Pump Discharge (Geodetic) (m)	236.67	
Driver Maximum (kW)	7.5	
Driver Voltage (V/phase/frequency)	575/3/60	
Driver Type	Direct Coupled	
Enclosure	TEFC	
Speed (max)	1750 rpm	
Motor Suitable for VFD	No	
Minimum Pump Efficiency at Design Point (%)	45	
Acceptable Manufacturers	Hayward Gordon ITT AC Wemco/Hidrostal	

N/A – not applicable.
BM – By Manufacturer
Manufacturer shall indicate flow at secondary TDH of 10.34 m in the submittal.

VARIABLE SPEED DRIVES

1. GENERAL

1.1 Work Included

.1 Supply, installation, verification of the On-Site equipment installation and performance verification of two (2) VSDs for vertical turbine pumps in the residuals area.

1.2 Standards

.1 All VSDs supplied under this Contract shall meet or exceed the following Specifications.

.2 The adjustable speed controller shall be designed to operate under continuous duty with a standard squirrel cage induction motor with a 1.15 S.F. and a vertical wet pit pump.

.3 VSD units shall be CSA certified.

1.3 Tests

.1 Factory testing

.1 VSD units are to be factory tested with the pumps and motors prior to shipment. Provide confirmation from factory of actual tests completed and results. Factory testing shall be conducted in accordance with Section 11300 – Process Pump General Requirements.

.2 Field testing

.1 The VSD Manufacturer's Representative shall provide On-Site start-up assistance, fine-tuning, and operator training.

.2 The VSD Manufacturer's Representative shall provide Site functionality test reports indicating proper installation and operation settings

.3 The VSD Manufacturer's Representative shall verify the unit and system performance by demonstrating that the VSD meets the performance requirements as defined in Section 01650 – Equipment Installation.

.4 Allow for all costs and labour for as many trips as necessary to complete requirements.

2. PRODUCTS

2.1 Variable Speed Drives

.1 VSD as supplied by the following acceptable Manufacturer:

.1 MagnaDrive Corporation.

.2 Design Requirements

.1 Design and provide VSD systems consisting of the VSD rotor assembly, actuator assembly, and other components necessary for a complete operating system. The VSD assembly shall include a cylindrical motor support assembly for use with vertical motors and vertical pumps.

.2 The design of the VSD shall include air cooling system.

.3 It shall be the responsibility of the Contractor to design and provide the vertical pump discharge head that will support the vertical VSD, its cylindrical motor support assembly, and the motor.

.4 The VSD system shall be rated on the basis of peak torque and heat dissipation requirements as determined by actual design load. The motor design speed and peak design load shall be determined by the Contractor when selecting the appropriate pumps.

.5 The Contractor shall convert the motor speed to the design operating speed throughout the design range of operation. Peak load speed and the minimum load speed shall be designed to preclude operation above the VSD heat dissipation capacity.

.6 The VSD shall be provided with a nonreversible ratchet device to prevent reverse rotation of the pump and line shaft.

.7 An electric actuator shall be supplied with each VSD in accordance with Specification Section 15202 – Process Valves and Operators.

.8 The VSD shall be designed to accommodate the vertical thrust at the maximum flow AFBMA-B10 bearing life of 40,000 hours.

.9 Adjustable shaft couplings shall be used to connect the motor and load shafts and shall be supplied by the Contractor.

.3 Environmental Capabilities:

.1 The drive shall operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Ambient temperature: 10 to 30° C.

.2 Humidity 20 to 100% (non condensing).

.3 Vibration up to 0.5 g.

.4 Altitude 0 to 1250 m.

.4 Components:

.1 At a minimum, the following components shall be included:

.1 VSD

.1 Air cooled conductor assembly with plated steel rotor plates and copper or aluminum conductors, and stainless steel fasteners.

.2 Alloy steel conductor hub input shaft.

.3 Output rotor assembly with anodized aluminum magnet rotors, electroless nickel and tin-plated neodymium-iron-boron magnets, steel hubs and output shaft, and stainless steel fasteners.

.4 Air gap adjustment shall be provided by an acme screw actuator gearbox with an inner tube assembly with rack and pinion or centre pivot for air cooled drives.

.5 Powder coated steel housing assembly.

.6 Coolant flow and outlet temperature protective controls for water cooled drives.

.7 Oil flooded lubricated gearbox/bearing housing with bearing temperature controls. Force feed lubrication will not be accepted.

.2 Actuator Assembly

.1 Provide actuator assembly capable of regulating drive air gap.

.2 The actuator shall be in accordance with Section 15202 – Process Valves and Operators.

.3 Cylindrical Motor Support Assembly for Vertical Installations

.1 Provide cylindrical motor support assembly capable of supporting the motor. Provide integral mounting flanges to accommodate motor and the pump head.

.2 The VSD shall be contained within the motor support assembly.

.3 Vertical thrust restraint shall be included for vertical drives.

.4 Powder coated.

2.2 Spare Parts

.1 Provide one (1) set of seals for each VSD supplied.

.2 Provide replacement lubricating oil for each VSD.

3. EXECUTION

3.1 Operations and Maintenance Manual

.1 The Contractor shall provide at a minimum, the following data:

.1 Overall VSD system operating data, including efficiency at the rated load and speed.

.2 VSD installation, O&M Manual.

.3 Overall actuator operating data.

.4 Actuator installation, O&M manual.

.5 VSD and actuator dimensional general arrangement Drawings.

.6 Itemized bill of materials listing all system components.

.2 Installation

.1 Provide all relevant information to the Installation Contractor regarding mounting requirements including concrete pads for all floor mounted equipment. Complete Form 101 as illustrated in Section 01650 – Equipment Installation.

.2 Inspect VSD for proper installation and operation settings and complete Form 102 as illustrated in Section 01650 – Equipment Installation. Record inspection results data and append to Form 102.

.3 Perform functional test on each VSD as identified in Clause 1.3 and complete Form 103 as illustrated in Section 01650 – Equipment Installation. Record test data and append to Form 103.

.3 Field Quality Control

.1 The Contractor shall be responsible for the testing and performance verification of each VSD as specified in Section 01650 – Equipment Installation and to the satisfaction of the Contract Administrator and the City. The Contractor shall allow for a Manufacturer's Representative to completely calibrate all drives after installation On-Site.

END OF SECTION

1. GENERAL

1.1 Work Included

.1 The Work includes the supply, delivery, installation, and supervision of the installation, testing and performance verification of the of submersible screw impeller pumps in addition to providing training to plant operations and maintenance staff.

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of the latest version of HIS.

1.3 Submittals

.1 Submit in accordance with Sections 01300 – Submittals and 11300 – Process Pumps General Requirements.:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately design points, head, capacity, horsepower demand and overall efficiency required at guarantee point.

.4 Power and control wiring diagrams, including terminals and numbers.

.5 Complete motor nameplate data, as defined by NEMA, from motor manufacturer.

.6 Factory finish system.

.7 Bearing life calculations.

.2 Quality Control Submittals:

.1 Factory and Field Performance Test Reports and Log.

.2 Manufacturer's Certification of Compliance that factory finish system meets requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Suggested spare parts list to maintain equipment in service for period of one (1) year and five (5) years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 O&M manual.

1.4 Shipment, Protection, and Storage

.1 Ship pre-assembled to the degree possible. Inform Contractor of any Site assembly requirements.

.2 Identify special storage requirements.

.3 The Contractor shall be responsible for on-site storage as per Manufacturer's recommendations to prevent damage, undue stress or weathering.

1.5 General Equipment Stipulation

.1 Supplements at the end of this Section list approved Manufacturer's and where specified models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these Specifications, and that fit within the piping and equipment layout shown in the Contract Drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the Specifications before including the price in their bid.

.2 The supply of equipment under this Section shall come from a single Manufacturer.

2. PRODUCTS

2.1 General

.1 Pump and Electrical Driver: Meet requirements for class, group, and division location in accordance with NFPA 70.

2.2 Supplements

.1 Pump data sheets and any other specific requirements are attached to this Section as supplements.

2.3 Description

.1 Provide pumps which are capable of running dry for prolonged periods.

.2 Design pumps to automatically connect to the discharge elbow when lowered into place, and easily removable for inspection or service without the need for personnel to enter the pump well.

.3 Provide close coupled integral, wetwell submersible type pump and motor assemblies for a sludge application. The sludge concentration is approximately 2% suspended solids.

.4 Seal the pump to the discharge elbow by a simple linear downward motion of the pump. Provide a sliding guide bracket attached to the pump.

.5 Guide the entire weight of the pump by a double guide bar and press the pump tightly against the discharge elbow with metal to metal contact.

2.4 Acceptable Manufacturers

.1 Hayward Gordon.

.2 ITT-AC

.3 KSB

.4 Wemco/Hidrostal

2.5 Materials

.1 Fabricate pump from materials suitable for sludge service.

.2 Fabricate impeller of hardened high chrome iron, ASTM A532, with minimum Brinell hardness of 550.

.3 Fabricate casing of cast iron, ASTM A48, with no less than 3% nickel.

.4 Fabricate suction liner of Ni-hard or hardened high chrome iron, ASTM A532, with minimum Brinell hardness of 550.

.5 Fabricate shaft of steel, ASTM A108, Grade 1141 or 1045.

.6 Fabricate shaft sleeve of stainless steel, ASTM A276, Type 416 or 420, with minimum Brinell hardness of 450.

.7 Manufacture pump bases of cast iron or fabricated steel

.8 Fabricate lifting chain or cable of stainless steel.

.9 Fabricate guide rails of stainless steel.

2.6 Impeller

.1 Provide spiral screw type impeller combining the action of positive displacement screw and a single vane centrifugal impeller.

.2 Provide conical geometry of the impeller and suction pieces to maintain optimum running clearances along the entire length of the impeller.

.3 Statically and dynamically balance impellers.

.4 Secure impeller to shaft with an impeller bolt, formed to shed stringy material.

2.7 Pump Volute

.1 Single piece, non-concentric design.

.2 Fit a wear ring to the volute inlet to provide efficient sealing between the volute and the impeller.

2.8 Motor

.1 Motor types, voltages, service conditions and power ratings are indicated in the detailed pump specification sheets.

.2 Provide motors that comply with the provisions of Section 11301 – Process Motors.

.3 VFDs are specified in Division 16. Certify compatibility between pump motor and VFD Manufacturer's as specified in Section 11060 – Process Motors.

2.9 Seals

.1 Oil chamber between seals shall be equipped with drain and inspection plug. Plug shall have positive anti-leak seal and shall be easily accessible from outside. Provide leak detection output signal to control panel.

2.10 Cables

.1 Provide approved 50 W type cables, with a 90°C rating and neoprene jackets.

.2 Seal the junction chamber, containing the junction board, from the motor with an O-ring compression seal.

.3 Connect the cable conductors and stator leads with threaded binding posts permanently mounted into the terminal insulation board, and thus permanently leak-proof.

.4 Provide the cable entry body with a strain relief function (separate from the cable sealing function) which strain relief is to be applied from the outer side of the cable entry assembly.

.5 Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NEC specifications for pump motors. Cable shall be of sufficient length to reach junction boxes without strain or splicing.

2.11 Accessories

.1 Lifting Arrangement: 2500 mm minimum, stainless steel chain, and one "grip-eye." Attach chain permanently to pump and access platform with stainless steel wire rope. "Grip-eye" will be capable of being threaded over and engaging links of stainless steel chain so pump and motor may be lifted with "grip-eye" and independent hoist.

.2 Sliding guide bracket shall be integral part of pump unit. Pump unit shall be guided by no less than 2 guide bars, or equivalent cable system, and pressed tightly against discharge connection elbow with metal-to-metal contact or through use of profile-type gasket, provided that gasket is attached to pump's flange and can be easily accessed for inspection when pump is lifted out of wetwell.

.3 Power cable.

2.12 Source Quality Control

.1 Control Panel:

.1 Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

.2 Factory Tests and Adjustments: Test all control panels furnished.

.2 Pump:

.1 Factory Performance Test:

.1 In accordance with HIS 1.6, for centrifugal pump tests.

.2 Include test data sheets, curve test results, performance test logs.

.2 Conduct on each pump.

.3 Perform under actual or approved simulated operating conditions.

.1 Throttle discharge valve to obtain pump data points on curve at $^{2}/_{3}$, $^{1}/_{3}$, and shutoff conditions.

.3 Motor Functional Test: Perform Manufacturer's standard motor test. Submerge and run for thirty (30) minutes at pumping conditions corresponding to maximum motor load.

2.13 Spare Parts

.1 Provide the following spare parts for each size of pump:

.1 One (1) bearing set per pump.

.2 One (1) seal per pump.

.3 Two (2) suction cones for each size of pump.

.4 Fort each pump type and size, provide a single impeller wear plate suction ring (if replaceable), one (1) pump shaft, and nut.

.5 One (1) complete set of special tools required to dismantle pump.

3. EXECUTION

3.1 Installation by the Contractor

.1 Installation will be in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Connect suction and discharge piping without imposing strain to pump flanges.

.2 No portion of pump shall bear directly on floor of sump.

3.2 Finishing

.1 Field finishing and touch up shall be as specified in Section 09901 – Painting and Finishing – Process Mechanical.

.2 Factory Finishing shall be in accordance with the Manufacturer's recommendations and Section 119001 – Factory Applied Protective Coatings.

3.3 Field Quality Control by Installation Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.1 mm or velocities in excess of 3 mm/sec.

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Flow Output: Measured by plant instrumentation and storage volumes.

.4 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips.

.4 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train O&M staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Installation Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer’s Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below are a part of this Specification.

.2 Data Sheets:

.1 Thickened Sludge Equalization Tank Pumps: P-R710B, P-R720B

END OF SECTION

SUPPLEMENT 1 – THICKENED SLUDGE EQUALIZATION TANK PUMPS

PARAMETER	VALUE	
Tag No. (s)	P-R710B, P-R720B	
Location	Thickened Sludge Equalization Tank (Inside / Non-Hazardous Area)	
Type of Installation:	Submersible with Easy Out	
Design Point Flow Capacity (L/s)	Primary: 25.1	Minimum: 14.1
Design Point TDH (m) (excludes losses internal to pump)	Primary: 30.5	Secondary: 18
NPSH Required (Head (m) at Design Flow)	By Manufacturer	
Flow Operating Range (L/s)	14.1 – 25.1	
TDH Operating Range (m)	18-30.5	
Fluid Temperature Operating Range (◦C)	0.5-25	
Solids Concentration Operating Range (%)	0.1-3	
Minimum Suction Water Elevation (Geodetic) (m)	231.75	
Pump Room Finished Floor (Geodetic) (m)	239.41	
Maximum Suction Water Elevation (Geodetic) (m)	5.5	
Driver Maximum (kW)	22	
Driver Voltage (V/phase/frequency)	575/3/60	
Speed (max) (rpm)	1800	
Motor Suitable for VFD	Yes	
Minimum Pump Efficiency at Design Point (%)	74	
Motor Protection System	Moisture and Thermal Sensors	
Design Standard	Weir Pumps Canada, Wemco-Hidrostal Screw Centrifugal Pump Model D4K-LT-1-DNXT2	
Acceptable Manufacturer	Weir Pumps Canada Hayward Gordon Ltd.	

Note: Provide all related accessories such as guide rails system c/w intermediate supports and holders system, Chains, Anchor bolts, discharge connections, Control Panel, VFDs as required for complete working system

POLYMER FEED SYSTEM

1. GENERAL

1.1 References

.1 The unit shall be in compliance with the appropriate sections of the following codes:

.1 NSF International, Standard 61 - Drinking Water System Components.

.2 American Gear Manufacturers Association (AGMA).

.3 American Institute of Steel Construction (AISC).

.4 American Iron and Steel Institute (AISI).

.5 American Society of Mechanical Engineers (ASME).

.6 American National Standards Institute (ANSI).

.7 American Society for Testing and Materials (ASTM).

.8 Canadian Electrical Code (CEC).

.9 Canadian Standards Association (CSA).

.10 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.11 Electrical Safety Authority (ESA).

.12 Institute of Electrical and Electronics Engineers (IEEE).

.13 Instrumentation, Systems and Automation Society (ISA).

.14 National Electrical Code (NEC).

.15 National Fire Protection Association (NFPA).

.16 National Electrical Manufacturers Association (NEMA).

.17 Steel Structures Painting Council (SSPC).

.18 Manitoba Building Code.

.19 Canadian Plumbing Code (CPC).

.20 Occupational Safety & Health Act (OSHA).

1.2 Contractor Submittals

.1 Shop Drawings:

.1 Make, model, weight, horsepower, and cross sectional details and colour brochures of each equipment assembly.

.2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.

.3 Detailed mechanical Drawings showing the equipment location and dimensions, size and locations of connections, weights of associated equipment, and construction details.

.4 Performance Specifications of all items of equipment.

.5 Process schematics associated with all items of equipment.

.6 Instrument layout of the control panel.

.7 Power and control wiring diagrams, including terminals and numbers.

.8 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.

.9 Factory finish system.

.10 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.11 External utility requirements air, water, power, etc for each component.

.2 Submittal of Interface Material: The following materials, defining the interface between the system specified herein and the remainder of the WTP, plus any additional information called for in these Specifications, shall be submitted to the Contract Administrator within 90 days following execution of Contract, and prior to any construction or fabrication that requires interfacing with the system.

.1 Identification, description, and envelope dimensions for each separately installed subassembly or piece of equipment and the associated connection dimensions to permit incorporation of the system selected into the design of the WTP.

.2 Information on field and installation requirements, including mounting requirements, access, and approximate total weight of each piece of equipment.

.3 A detailed description of the instrumentation and control system, including a list of all functions monitored, controlled and/or alarmed. Describe all automatic shutdown features and interfaces with the WTP instrumentation and control systems. The description of the instrumentation and control system shall be in both word and schematic form. Schematics shall be in accordance with City of Winnipeg standard as indicated on the P&IDs.

.4 Clearly identify the tag name, model numbers and catalogue numbers for each piece of equipment, component, device, etc., within the Product's technical literature. Use tag numbers as indicated on P&IDs. Clearly identify these model numbers using red ink on all of the Manufacturer's technical literature, such as but not limited to, instruction manuals, technical bulletins, and Manufacturer's Specification Sheets (i.e., Manufacturer's Cut Sheets).

.5 All Drawing submittals shall conform to Drawing number and tagging conventions as indicated on the P&IDs. Use same equipment tags as indicated on P&ID on all Drawing submittals. All drawing submittals shall conform to the City of Winnipeg schematic standard as indicated on the P&IDs.

.6 Electric motor control schematics. Include locations of control stations, and any special control to be provided by Division 16 & 17. Coordinate polymer controls with WTP control System.

.7 A complete description of all interfaces between the system components and between the system and other WTP components. Provide a summary by interface link for the following:

.1 Number, size, and type of all process and auxiliary connections.

.2 Number, size, and type of electronic or electrical signal wires.

.3 Number, size, and type of electrical power wires.

.8 Control panel envelope dimensions, mounting requirements, and access requirements (doors, louvers, etc.).

.9 Fully commented ladder logic listings, I/O printouts, and cross-reference printouts documenting Programmable Controller software program.

.3 Informational Submittals:

.1 Field Performance Test Report.

.2 Special shipping, storage and protection, and handling instructions.

.3 Manufacturer's printed installation instructions.

.4 Certificate of Satisfactory Installation (Form 102).

.5 Suggested spare parts list to maintain the equipment in service for a period of one (1) year. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Operation and Maintenance (O&M) Manuals: As specified in Section 01730, Operation and Maintenance Manuals.

.8 As specified in Division 17.

1.3 Preparation for Shipment

.1 Insofar as is practical, equipment specified herein shall be factory assembled and tested. Parts and assemblies that are of necessity shipped unassembled shall be packaged and tagged in a manner that will protect equipment from damage and facilitate final assembly in the field. Machined and unpainted parts shall be protected from damage by elements with application of a strippable protective coating.

1.4 Required Spare Parts and Special Tools

.1 Spare parts shall be shipped in a wooden box and shall be protected from damage, from moisture and dirt accumulation. Parts shall be protected as for an extended storage period. The box shall be heavily constructed with hinged cover, hasp, and lock, and designed as a permanent storage enclosure for the spare parts. The spare parts shall, if possible, be enclosed within an airtight membrane. Spare parts supplied in matched sets, such as drive belts, shall be wrapped, bound, or labeled to indicate a set.

.2 Furnish one (1) year supply of lubricants including oil and greases, as recommended by the Product Manufacturer. The lubricants shall include summer and winter grades along with alternative references to equal products of other Manufacturers including Specifications such as AGMA numbers, viscosity.

.3 Furnish for each piece of equipment

.1 One (1) complete set of packing.

.2 One (1) complete set of bearings.

.3 One (1) complete set of gaskets and O-ring seals.

.4 One (1) complete of set of rod washers.

.5 One (1) complete set of keys, dowels, pins, etc.

.6 One (1) stator for each type of pump, if required

.7 One (1) rotor for each type of pump, if required

.8 One (1) connecting rod with pair of universal joint(s), if required

.9 One (1) complete set of any special tools.

2. PRODUCTS

2.1 General

.1 Supplements at the end of this Section list Acceptable Manufacturers, and where specified models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid.

.2 The supply of progressing cavity pumps under this Section shall come from a single Manufacturer.

.3 All Equipment in this Section shall be supplied as a Vendor Package by:

.1 Fluid Dynamics (Semblex)

.2 CIBA

.3 Tomal

2.2 Polymer Bulk Bag Unloading and Conveyance System

.1 The Polymer Bulk Bag Unloading and Conveyance System will convey dry polymer stored in the Dry Polymer Storage Room to the upper level of the Polymer Preparation and Chemical Feed Room. Two (2) Polymer Bulk Bag Unloading and Conveyance Systems shall be provided with one dedicated to the Filter Aid Polymer System and one dedicated to the Sludge Polymer System. The bulk bag unloading system shall have a bulk bag frame with monorail and hoist that will receive bulk bags of dry polymer. A bulk bag lifting yoke suspended by the hoist and trolley system shall support the dry polymer bulk bags during unloading. The bulk bags shall unload its contents to a feed hopper. The bag unloading system shall be complete with bulk bag agitation device to ensure consistent discharge and minimize caking and clogging. The bulk bag interface to the feed hopper shall be designed to provide a dust tight sealed connection. Dry polymer unloaded to the feed hopper shall be conveyed to the Polymer Preparation Room via a pneumatic conveyance system.

.2 Capacities and Performance

.1 Design Criteria

Number of Units (duty)	2
Filter Aid Dry Chemical Feed Transfer Rate (Kg/d)	100
Sludge Dry Polymer Chemical Feed Transfer Rate (Kg/d)	50
Supply Voltage (V/ph/Hz)	600 / 3 / 60

.3 General

.1 All components of the Polymer Bulk Bag Unloading and Conveyance System shall be specifically designed for the intended chemical, and shall be constructed from appropriate corrosion and abrasion resistant materials.

.2 Provide two (2) Polymer Bulk Bag Unloading and Conveyance Systems that will convey dry polymer stored in the Dry Polymer Storage Room to the upper level of the Polymer Preparation and Chemical Feed Room.

.3 The Polymer Bulk Bag Unloading and Conveyance Systems shall use a pneumatic blower system to transfer dry polymer from each unit's feed hopper to the upper level of the Polymer Preparation and Chemical Feed Room. Size pneumatic blower appropriately to ensure dry polymer can be blown to polymer preparation equipment on upper level of the Polymer Preparation and Chemical Feed Room.

.4 All components of each Polymer Bulk Bag Unloading and Conveyance unit including blower, screw conveyor, level switches, weight scales, and hoist & trolley shall be pre-plumbed and pre-wired.

.5 All interconnecting piping and polymer conveyance piping from Polymer Bulk Bag Unloading and Conveyance to Polymer Preparation units shall be supplied and installed by the Contractor.

.6 All components of the storage conveyance systems that come into contact with the dry polymer are to be electrically grounded to prevent static charge buildup.

.4 The Polymer Bulk Bag Unloading and Conveyance System with pneumatic blower shall incorporate the following:

.1 Bulk Bag Handling System

.1 The feeder module shall have a structure with provisions to hang and support up to a 1,500 kg bulk polymer bag. The bulk bag handling assembly shall be provided with overhead rail, trolley and hoist, a support frame and lifting bar. The trolley and hoist shall permit moving and placing the bulk bag in position above a bin discharger. The overhead rail shall extend out from the bulk bag unloader a sufficient distance where the hoist can pick up a bulk bag of polymer placed in front of the containment curb. The bulk bag handling assembly shall be provided with a support frame and lifting bar.

.2 Storage hopper to include an adapter nozzle for dust-tight attachment of bulk bag spout, an adjustable vibrator and a gasketted quick release door for easy access to bag snout. A valve shall be provided between the storage hopper and the access door to isolate the bulk bag contents when tying or untying the bulk bag snout.

.3 Storage hopper and all parts in contact with polymer shall be fabricated from stainless steel.

.4 Provide two (2) heavy duty, electrically operated wire rope type hoists and fabricated steel type electric powered trolleys, each with a minimum rated capacity of 2 metric tonnes. Trolley motors to be TEFC. Safety factors used in the design of the hoist and monorail system shall be not less than five (5). The design of the hoist and trolley shall be such that all movement will take place smoothly and positively. Not slipping of the load shall occur at any time. The design of the hoist and monorail system and accessories shall conform to Code of the Safety Standards for Cranes, Derricks and Hoist, as sponsored by ASME and ANSI, and to CSA and Manitoba Department of Labour requirements. The complete design of the trolley, hoist, rail system and support frame shall be the responsibility of the Contractor, and shall include shop drawings sealed and signed by a Professional Engineer registered in the Province of Manitoba.

.5 Bulk bag support frame to include load cells and summation module to weigh and transmit a 4 to 20 mA weight signal of the bulk bag to the polymer PLC. The summation module shall support net weight and tare weight calculations. A local NEMA 4X panel shall be provided to house the summation module including local weight display and tare adjustment.

.6 Provide a low-level sensor complete with alarm on the dry polymer storage hopper. Sensor shall be in accordance with Division 17.

.7 Provide one (1) 1500 mm (W) by 2300 mm (L) all aluminum construction access platform complete with alternating tread stair for access. Height of platform shall be determined by the Contractor. Access platform to be installed in the location as shown on the Drawings. The access platform shall have a continuous 125 mm high kick plate and double row handrails along all open sides. Handrail shall be of circular cross section continuously graspable along its entire length, minimum diameter of 30 mm and maximum diameter of 50 mm and finished with an Architectural Class I Anodic Coating, AA-C22A41 clear. Top rail not less than 1070 mm above the platform on which it is installed and intermediate rail midway between the top rail and platform. Design of handrail systems, anchorage, connections, and all other associated components shall meet the design requirements of the applicable Building Codes. The access platform shall be designed to support a 4.8 kPa live load. The complete design of the access platform shall be the responsibility of the Contractor, and shall include shop drawings sealed and signed by a Professional Engineer registered in the Province of Manitoba. A volumetric screw feeder shall be used to meter dry polymer from the storage hopper to the pneumatic transfer line.

.8 A hopper vibrator shall be provided on the lower portion of the hopper to prevent bridging. The screw feeder housing and hopper shall be of stainless steel construction.

.9 The feeder and hopper materials in contact with dry polymer shall be of stainless steel construction.

.2 Dry Polymer Conveyance

.1 A regenerative type low-pressure blower shall be provided to pneumatically convey the dry polymer to the wetting unit via a transport pipe. The transport pipe shall be constructed of stainless steel complete with long radius elbows supplied and installed by the Contractor.

.2 The blower shall be designed for continuous operation. The blower shall be equipped with a TEFC 600/3/60 motor. Control of the blower shall be interlocked with that of the polymer blending unit.

.3 The dry polymer feeder shall discharge into an enclosed stainless steel feeder. The feeder shall be heated to prevent condensation and moisture from forming. From the feeder, dry polymer shall be pneumatically conveyed through stainless steel tubing to the wetting unit atop the mix tank. Feed conveyance shall be a completely closed system to prevent drifting of airborne polymer dust and polymer spills in the event of a malfunction.

.4 A level sensor shall be provided in the feed funnel to indicate a high polymer alarm. Sensor shall be in accordance with Division 17.

.3 Anchor Bolts and Inserts

.1 All assembly bolts, anchor bolts, nuts, and washers shall be 316L stainless steel if wetted (including high humidity or areas subject to spray) and galvanized steel if non-wetted. Contractor to ensure compatibility of dissimilar metals.

2.3 Polymer Preparation Equipment

.1 The fully automatic Polymer Preparation Systems shall be capable of wetting, diluting and aging polymer solutions from 0.1% to 0.5%. Dry Polymer will be delivered in 400 to 1000 kg bags as supplied by the City. The Polymer Preparation Systems must capable of preparing long chain polymers without imparting excessive shear. Mixed polymer shall be free of polymer clots and fish eyes.

.2 An emulsion polymer system shall be included as an emergency stand-by unit as specified herein.

.3 Capacities and Performance

.1 Design Criteria

Description	**Filter Aid Polymer Preparation System**	**Sludge Polymer Preparation System**
Minimum Mixing Water Temperature (°C)	10	10
Polymer Specific Gravity	1.00 – 1.14	1.00 – 1.14
Polymer Concentration Range (%)	0.1 - 0.5	0.1 - 0.5
Polymer Design Concentration (%)	0.5	0.5
Minimum Polymer Dose (mg/L)	0.01	1.0
Minimum Pure Polymer Usage (kg/d)	1.0	0.1
Maximum Polymer Dose (mg/L)	0.05	5.0
Maximum Pure Polymer Usage (kg/d)	20.4	4.7
Minimum WTP Flow (ML/d)	100	0.06
Maximum WTP Flow (ML/d)	407	2.33

.4 General

.1 All components of the Polymer Preparation Systems shall be specifically designed for handling the intended chemicals and shall be constructed from appropriate corrosion and abrasion resistant material.

.2 All equipment specified in this Section shall be designed and furnished by a single polymer equipment Manufacturer who is responsible for component compatibility and suitability to the application. Installation shall be by the Contractor.

.3 Provide the following:

.1 Supply and install one (1) Filter Aid Polymer Preparation System.

.2 Supply and install one (1) Sludge Polymer Preparation System.

.4 Polymer preparation units shall be sized for a design polymer concentration of 0.5%.

.5 Each polymer preparation unit shall have tankage for mixing and storage with sufficient capacity to allow for adequate aging and storage of polymer solution. Mixing and storage tank operations to be automatic, controlled by the Polymer PLC.

.6 Contractor shall supply a complete and functional system that shall be controlled by the polymer PLC.

.7 Provide sufficient mixing energy to activate long chain polymers without imparting excessive shear.

.8 Provide Polymer Preparation System that operates on an automatic, sequential cycle to prepare fully active polymer solution.

.9 The dry polymer to be utilized in the system will be in the microbead or powder form. The dry polymer used can either have a cationic, anionic or non-ionic charge.

.10 Dry polymer shall be conveyed from the Dry Polymer Storage Room to the Polymer Preparation Unit utilizing Pneumatic conveyance.

.5 Wetting Unit

.1 Provide a polymer wetting unit capable of preparing long chain polymers without imparting excessive shear.

.6 Mixing/Aging Tank

.1 Provide mixing/aging tank(s) and appurtenances for mixing of the polymer solution after discharge from the wetting unit and before transfer to the feed tank.

.2 Construct the mixing/aging tank of FRP or equal, to be free standing.

.3 Mixing/Aging tank(s) must include support for mixer bridge.

.4 Provide the mixing/aging tank with a capacity adequate to meet polymer system demand.

.7 Blending Water Control

.1 Each unit shall incorporate a blending water switch (flow or pressure) to monitor blending water flow and if required shut down the polymer preparation process on low water flow.

.8 Mixer

.1 Provide a mixer for the mix tank, fixed and mounted to the tank top bridge.

.2 Mixer to be driven by a TEFC electric motor, operating on 600/3/60 power, conforming to Division 16.

.3 Ensure all wetted parts of the mixer are stainless steel.

.9 Transfer Valves and Piping

.1 Provide system to transfer solution from mix tank to feed tank. System shall operate by gravity, with automated valves, controlled by the polymer PLC.

.2 A motorized ball valve shall be provided to transfer polymer solution from the mix/age tank to the feed tank.

.3 Overflow and drain lines to be supplied and installed by the Contractor.

.4 Include solution transfer time when sizing related equipment.

.10 Liquid Level Control Sensors

.1 Provide liquid level control sensors to detect liquid levels in the mix tank.

.2 Ensure all level devices are integrated into the PLC.

.3 Liquid level sensors shall consist of either:

.1 Ultrasonic Level Transmitter.

.2 Non-fouling conductance level probes.

.4 Provide all control components in accordance with the requirements of Division 17 and the P&ID Drawings.

.11 Motor Starters and Starter Cabinet

.1 Provide motor starters and panel to house the motor starters for the system.

.2 Provide starter panel with a NEMA 4X rated enclosure. Provide panel and panel wiring in accordance with Division 16.

.12 Tank bottom Drain

2.4 Polymer Feed and Post Dilution System

.1 The Polymer Feed and Post-Dilution Systems shall be capable of storing prepared polymer solution, feeding and post-diluting the polymer solution to the filter aid and Sludge systems. Prepared polymer solution from the polymer preparation units will be conveyed by gravity to two (2) polymer solution feed tanks. The Filter Aid and Sludge polymer solution feed pump skid systems shall convey prepared polymer solution from the feed tanks to their respective process dosing points. As the polymer solution is pumped to their respective polymer dosing points it shall be post-diluted with WTP service water.

.2 Capacities and Performance

.1 Design Criteria

POLYMER FEED SYSTEM

Description	**Filter Aid Polymer Feed and Post-Dilution System**	**Sludge Polymer Feed and Post-Dilution System**
Temperature (°C)	10	10
Polymer Specific Gravity	1.00 – 1.14	1.00 – 1.14
Polymer Concentration Range (%)	0.1 - 0.5	0.1 - 0.5
Feed Tank Capacity (L)	4,000	2,500
Polymer Feed Pumps (Duty + Stand-by)	2 + 1	1 + 1
Number of Pump Feeds	1	1
Number of Pumps Per Skid	3	2
Polymer Pump Type	Progressing Cavity	Progressing Cavity

.3 All components of the Polymer Feed and Post-Dilution System shall be specifically designed for handling the intended chemical and shall be constructed from appropriate corrosion and abrasion resistant materials.

.4 Polymer Feed Tanks

.1 Supply and install two (2) polymer solution feed tanks and related appurtenances. Tanks shall be sized as indicated in above table

.2 Closed top fibreglass tanks shall be provided. Tank height shall not exceed 4.0 m. Each tank shall have its respective working volume below the overflow outlet pipe and above the top of the discharge pipe. Tank shall be vertical design with integral flat bottom with no bottom or sidewall seam. Tank shall include a translucent exterior protective coating with UV inhibitor. Each tank shall have an appropriate hold down lug system.

.3 Accessories

.1 Provide an ultrasonic level transducer/transmitter in each feed tank. Level transmitters shall supply a 4-20 mA level signal and a discrete fault output to the Polymer PLC.

.2 Each feed tank shall have a clear 25 mm diameter PVC liquid level sight glass calibrated in litres c/w shutoff valve and vent

.3 Each feed tank shall have two (2) 316L stainless steel lifting eyes.

.4 Each feed tank shall be supplied with manway access doors

.5 Furnish each feed tank with the size and number of connections as indicated on Drawings.

.5 Progressive Cavity Pumps

.1 General

.1 Supply and install three (3) filter aid progressive cavity feed pumps and related appurtenances.

.2 Supply and install two (2) Sludge progressive cavity feed pumps and related appurtenances.

.3 Coordinate pump requirements with drive Manufacturer and be responsible for pump and drive requirements.

.4 Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller

.2 Pump Design

.1 Pumps shall have materials of construction selected for resistance to the pumped solution (0.5% polymer solution). For pumped solutions of non-corrosive materials, pump materials of construction shall be either Type 316 stainless steel or Viton. Each pump shall be a heavy-duty universal pin type. The pump and drive shall be mounted on a structural steel base plate complete with a drip rim, drainage connection, and suitable guards. Each pump shall have a minimum two-stage rotor to minimize slip and provide greater linearity.

.2 Suction and discharge nozzles shall have ANSI 125 pound flanges. Each pump shall be supplied with single-acting non-flushing mechanical seals.

.3 Each metering pump shall be equipped with a 600 V, 3-phase inverter duty motor.

.4 Pumps to be factory finished. Contractor shall prime and touch up damaged finishes to match original finish. Restore to new finishes that have been damaged to prime and touch up.

.5 Each progressive cavity pump VFD shall be provided with appropriate inputs and outputs to facilitate control from the PLC supplied under this Contract.

.3 Motor Starters and Drive Unit

.1 Supply motors in accordance with requirements of Division 11301 - Process Motors.

.2 Drive shall have the following features:

.1 Provide a single helical rotor of circular cross section, fabricated from 316 stainless steel. The rotor shall be driven in its path by either a positively sealed universal joint, or a sealed gear joint design.

.2 Provide a Buna-Nitrile stator, chemically bonded to the inside of a steel tube. Stators shall be manufactured to length. Stators manufactured in long lengths and cut to size are not acceptable.

.3 Mount pump and motor in-line along with associated drive appurtenances on a one-piece, fabricated steel baseplate with full drip lip, grout holes, drains, guard, shims, and accessories.

.4 Provide pumps with single-acting non-flushing mechanical seals.

.5 For each pump, provide a liquid filled ring-type pressure gauge and switch with hardwired interlock to the VFD. The VFD shall trigger a general alarm on shutdown due to high pressure, after appropriate time delay, in accordance with the requirements of Division 16.

.6 For VFD driven units, pump Manufacturer is responsible for the provision of the gear reducer between the motor and pump.

.7 Reduction ratio as required to operate the pump at its maximum operating speed when the motor is operating at its nominal rated full speed in accordance with Specifications.

.8 Provide gear motors or gear reducers.

.9 Gear reducer drive equipment designed to transmit 150% of the maximum torque under the full range of operating conditions.

.10 Each progressing cavity pump shall be supplied with a stator heat sensor with hardwired interlock to the VFD. The VFD shall trigger a general alarm on shutdown due to high temperature.

.11 VFD shall be supplied in accordance with Division 16

.4 Motor

.1 Suitable for use with variable frequency drive per NEMA MG1-31.

.2 Rated 600V, 3 phase, 60 Hz.

.3 Totally enclosed fan cooled (TEFC).

.4 External fan cooling. Fan to be independent of motor speed with own power supply

.5 Premium efficiency.

.6 Inverter duty

.7 Continuous duty.

.8 Class F Insulation.

.9 Speed as required to suit gear reducer and pump.

.6 Polymer Pump Skids

.1 General

.1 The Contractor shall fabricate pump skids and furnish equipment as shown in the P&IDs and described herein.

.2 The filter aid pump skid shall contain three (3) pumps. The Sludge pump skid shall contain two (2) pumps. Pump skids shall be sized appropriately to fit in the designated location in the Polymer Preparation and Chemical Feed Room, as shown in the included Drawings.

.3 All components of the polymer pump skids including pump, speed controller, motor, and post-dilution unit shall be pre-plumbed and pre-wired. Skid shall be 316L stainless steel and fork truck compatible. Mounting hardware shall be 316L stainless steel.

.2 Post-Dilution System

.1 System shall include a skid-mounted post-dilution unit for each pump consisting of a static mixer in a clear PVC housing, rotameter-type flow indicator with rate-adjusting valve, pressure gauge, solenoid valve and 316L stainless steel brackets. Pump skids shall be configured as indicated on the Drawings.

.3 Accessories

.1 Flow meters shall be in accordance with Division 17 Specifications.

.2 Each pump shall be supplied with pre-piped calibration column and pressure relief valve. The calibration column shall be constructed of clear PVC and shall be complete with a vented top cap. Each column shall be graduated in milliliters with a minimum capacity of 2,000 ml.

.3 The Contractor shall supply and install the following accessories:

.1 Interconnecting piping, fittings, reducers, valves, strainers, flexible fittings, quick connect connections and related appurtenances to make a complete system. All Interconnecting piping shall be Schedule 80 PVC.

2.5 Standby Emulsion Polymer Preparation System

.1 General

.1 The standby emulsion polymer preparation system shall be an integrated equipment package capable of preparing a homogenous polymer solution. The system shall be an automatically controlled, sequentially batching unit capable of preparing liquid polymer solution from emulsion feed stock. The standby emulsion polymer preparation system shall be a skid mounted assembly consisting of metering pump, mixing chamber, and all piping, valves, and controls required to deliver the required minimum and maximum litres per hour of polymer solution as shown herein. Included with each polymer feed system shall be a pressure relief valve, back pressure valve, and calibration column.

.2 Equipment

.1 General:

.1 A back-up emulsion polymer activation and blending system shall be provided to produce and feed a 0.1 - 0.5% concentration polymer solution to any of the three (3) feed tanks.

.2 Polymer feed system shall consist of an integrated equipment package system which shall meter, dilute, activate, mix, and feed liquid polymer and water. System shall not rely upon a static mixer as the means of polymer activation. Polymer shall not be exposed to a rotating centrifugal pump turbine or other machinery that would cause excessive shear.

.3 Feed systems shall include a suitable feed pump to provide the capability of pumping emulsion type liquid polymers. At no time shall liquid polymer or polymer solution be exposed to excessive shear, so as to degrade the effectiveness of the polymer molecular chains.

.4 Polymer feed system shall be furnished with an integrally mounted NEMA 4X control panel.

.5 Each polymer feed system shall be equipped with Type 316L stainless steel side frame and stainless steel base with nonskid feet.

.6 The Contractor shall supply products (modified as necessary) to provide the specified features and to meet the specified performance at the specified operating conditions.

.7 Polymer mixing system shall be specifically designed to invert, disperse, and activate in solution emulsion polymers which may vary in specific gravity from 0.98 to 1.14 and vary in viscosity from 80 to 6,000 cpl.

.3 Capacities and Performance

POLYMER FEED SYSTEM

.1 Design Criteria:

Description	Stand-by Emulsion Polymer Preparation System
Minimum Mixing Water Temperature (°C)	10
Polymer Specific Gravity	1.00 – 1.14
Polymer Concentration Range (%)	0.1 – 0.5
Polymer Design Concentration (%)	0.5
Minimum Polymer Dose (mg/L)	0.01
Minimum Pure Polymer Usage (kg/d)	1.0
Maximum Polymer Dose (mg/L)	0.05
Maximum Pure Polymer Usage (kg/d)	20.4
Minimum WTP Flow (ML/d)	100
Maximum WTP Flow (ML/d)	407

.2 Blending Water Control

.1 Mixing of concentrated (neat) polymer with water shall be accomplished with an appropriate mixing method.

.2 Each unit shall incorporate a blending water switch (flow or pressure) to monitor blending water flow and if required shut down the polymer preparation process on low water flow.

.3 All valves and piping indicated within the PID vendor package boundary for the Stand-by Emulsion Polymer Preparation shall be provided by Contractor.

.3 Pump

.1 Provide one (1) polymer pump to transfer emulsion polymer from tote to Stand-by Emulsion Polymer Preparation Unit.

.2 Polymer transfer pump shall be suitable type for transferring polymer, having materials of construction selected for resistance to the pumped solution.

.3 Polymer transfer pump motor to be TEFC

.4 Flow Meter

.1 Flow meters shall be in accordance with Division 17 Specifications.

.5 Polymer Tote Platform

.1 Provide one (1) 3100 mm (L) x 1800 mm (W) x 1000 mm (H) polymer tote platform. Design tote platform for two (2) full polymer totes. Polymer tote platform to be constructed from carbon steel and shall be coated with appropriate corrosion and abrasion resistant surface finishes.

.2 Polymer tote platform to include load cells and summation module to weigh and transmit a 4 to 20 mA weight signal of polymer totes to the polymer system PLC. The summation module shall perform net weight and tare weight calculations. A local NEMA 4 panel shall be provided to house the summation module and include local weight display with tare adjustment.

.3 All valves and piping from totes, to Standby Polymer Preparation Unit and from Standby Polymer Preparation Unit to feed tanks unit shall be provided by the Contractor.

.6 Controls

.1 Control of the Standby Emulsion Polymer Preparation System shall be integrated with Dry Polymer Feed System and performed through the polymer system PLC.

.2 A NEMA 4X type control panel shall be provided for the Standby Emulsion Polymer Preparation System.

.3 The control panel shall include adjustable time delay relays for pre-flush, post flush. Provide HMI.

.4 Dry contacts shall be provided in the control panel for remote input of the following statuses to the WTP PLC:

.1 System in Remote

.2 System Running

.3 Low Water Flow

.4 No Power

2.6 Instrumentation and Control

.1 General: Refer to Division 17 for general instrumentation and control requirements. All instrumentation, control, and electrical components provided under this Section shall comply with the requirements of Division 17.

.2 All instruments and devices indicated on the P&ID shall be provided, factory wired, and mounted.

2.7 Polymer preparation System Control Panel

.1 All control panels shall comply with the requirements of Division 17.

.2 The polymer preparation system shall be furnished with a NEMA 4X control panel (CP-C11) containing a factory mounted programmable logic controller (PLC). All controls and instruments shall fail into safe condition. Units shall not operate unless energized, nor can they operate under fault conditions.

.3 The polymer system programmable logic controller (PLC) as specified below shall start, sequence, alarm and shutdown the polymer system based on received local and remote inputs and outputs that provide automatic monitoring and control of all operating variables. The control panel will include an industrial grade PC as specified below to provide local operator monitoring and control. During normal operation, the PLC will receive flow command signals and start and stop requests from the WTP control system via Ethernet.

.1 Programmable Controllers:

.1 All PLC's shall be Modicon Unity hot standby processors complete with the redundant processors. No substitutes. They shall be supplied with Ethernet communication modules in order to enable the PLC to operate as a peer on the Ethernet WTP control network.

.2 Specific requirements of the PLC outlined in Division 17.

.3 Monitor data communications between the PLC and the WTP control system by passing data bits ("heart beat" check).

.2 Operator Controls and Interfaces: Provide an HMI with the following features:

.1 Color flat screen display.

.2 Membrane keypad.

.3 NEMA 4X (indoor only).

.4 Ethernet port.

.5 Provide programming software, license, and download cable.

.6 Display screens shall be configured to have the following capabilities:

.1 Display alarms and diagnostic data.

.2 Monitor system parameters.

.3 Operate all control loops in manual and switch loops from auto to manual.

.4 Operate all equipment and auxiliaries controlled by the PLC.

.5 Adjust PLC set points. (Alarm set point changes shall require PLC programming laptop).

.6 Read the status of all digital and analog I/O.

.7 Specific requirements outlined in Division 17.

.4 Provide separate panels for instrumentation/PLC and motor starters. A UPS supply for critical loads and a non-UPS supply for non critical loads such as a control panel convenience light and receptacle shall be supplied to the polymer system control panel by Division 16. Power to the motor starter panel will be supplied by Division 16.

.5 The polymer preparation unit PLC shall provide the following functions:

.1 Manual/automatic control of make-up cycles

.2 Start/stop batch cycles

.3 Mixer timer set time (seconds)

.4 Dry feeder timer set time (seconds)

.5 Dry feeder start and stop.

.6 Spout gate solenoid open and close.

.7 Vibrator start and stop

.8 Water solenoid valve open and close

.9 Mixer start and stop

.10 Transfer valve open and close

.6 Additional display functions shall include run indication for each mechanical device as required for operator interface and monitoring of the polymer equipment.

.7 Operation shall be sequential batch type, continuous and fully automatic. Upon low level (falling) in the mix tank, the transfer valve is closed and the air blower is energized to blow air through the pneumatic conveying line to the wetting unit atop the mix tank. After an operator adjusted time delay water begins flowing through the wetting device atop the mix tank and the dry polymer feeder delay timer (operator adjustable) is energized. Once the dry feeder delay timer times out dry polymer is metered and travels through the pneumatic conveying line to the wetting device. Intense water sprays thoroughly wet each individual dry polymer particle. Once the lower mixer impeller is covered with water, the tank mixer is energized. The dry feeder shuts down on a timer and the feeder shut-off gate closes. Mix tanks shall be configured such that the mixer is energized before dry polymer feed is started and there is sufficient space in the tank to meter all of the polymer required for a 0.5% batch concentration. At no time shall the dry polymer feeder operate without the mixer.

Water flow continues, filling the tank to the high level, at which time the high-level probe stops the water fill cycle and after a time delay de-energizes the air blower. At this point the adjustable mixer timer is started and the mixer continues mixing until it times out, signaling completion of the mix cycle. The newly mixed polymer batch continues aging until mid level (refill) is reached in the lower feed tank.

.8 When level probes in the feed tank signal refill, the mixed and aged batch is transferred via gravity to the feed tank by opening the electric actuated transfer valve. After transfer and low water level is reached in the mix tank, the transfer valve is closed and the mix/age cycle repeats.

.9 Semi-dilute 0.5 percent and aged polymer shall be continuously withdrawn from the bottom of the feed tank, with the mix tank preparing batches of newly mixed and aged polymer for recharging the feed tank.

2.8 Pump Skid Control Panels

.1 Each pump skid shall be supplied with a control enclosure housing electronic VFD's and the auxiliary control devices specified herein. The control enclosure shall be NEMA 4X. The WTP PLC shall start, alarm and shutdown the post dilution system and automatically monitor and control all operating variables. The enclosure front panel shall include a fusible disconnect switch (Supplied by Division 15, installed by Division 16), an "Computer-Off- Hand" selector, the VFD drive control interfaces, pump "Run" and "Fail" indicating lights and pump flow rate indication for each pump provided. In the "Hand" mode, the pump shall run continuously. In the "Computer" mode, the pump shall be controlled by the WTP PLC. Speed shall be controlled locally in the "Hand" mode, and from a remote 4-20 mA input signal when in the "Computer" mode. The WTP PLC shall be provided with pump running, pump ready, and pump in "Computer" mode discrete inputs and pump speed and drive current draw analog inputs.

.2 The control enclosure shall be supplied with a 575 VAC, 3-phase, 60 Hz. Power will be supplied by Division 16. The Contractor shall supply load requirements for all 2 supplies as a Shop Drawing submittal.

.3 The WTP PLC shall control the dose rate of the Filter Aid and Sludge polymer feed system based on totalized flow rates from their respective processes.

.4 The WTP PLC shall receive remote inputs to flow pace each polymer pump based on totalized flows from their respective processes. The Filter aid polymer pumps will be flow paced to the totalized flow through each ozone contactor train inferred from the flocculation/DAF influent flow meters. Filter Aid polymer pump 1 shall be flow paced by the combined total flow of DAF units 1 to 4 and Filter Aid polymer pump 2 shall be flow paced by the combined total flow of DAF units 5 to 8. The sludge polymer pump shall be flow paced to the totalized flow on the sludge discharge pipe upstream of the thickeners at the flocculation chamber

.5 The Manufacturer shall supply and install all wiring and conduit within a skid package. Cables between skids shall be supplied and installed by Division 16.

2.9 Piping and Tubing

.1 Supply and install all interconnecting piping and tubing within each skid mounted assembly. Unless otherwise specified, provide valves that are the Manufacturer's standard, suitable for the intended service conditions.

.2 Run all piping in vertical and horizontal planes. Arrange piping to ensure that undue stresses from thermal expansion are not transmitted to equipment components. Do not route piping in locations or at heights that will create tripping hazards or impede the required movement of personnel.

2.10 Accessories

.1 Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely mounted on all equipment provided under this Section in a readily visible location. Plate shall bear the 10 mm (3/8-inch) engraved and black enamel filled equipment identification number indicated in this Specification and/or as shown on Drawings.

.2 Lifting Lugs: Equipment over 50 kg (100 lbs) in weight shall be provided with lifting lugs.

.3 Anchor Bolts: Anchor bolts shall be Type 316L stainless steel and at least 13 mm in diameter. Coordinate required size with final Shop Drawings.

2.11 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be by the Contractor in accordance with the Manufacturer's printed installation instructions.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901, Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

.2 Functional Tests: Conduct on each piece of equipment.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Flow Output (where applicable): Measured by WTP instrumentation and storage volumes.

.3 Operating Temperatures: Monitor bearing areas on equipment and motor for abnormally high temperatures.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	8	103
5	Operator and Maintenance Training	8	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that whole system, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supply of Chemicals

.1 The City will be responsible for supplying all chemical required for the new polymer make-up equipment. Coordinate requirement for chemicals with the Contract Administrator.

3.9 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Filter Aid Polymer Pumps: P-C061A, P-C062A, P-C063A.

.2 Sludge Polymer Pumps: P-C071A, P-C072A.

END OF SECTION

SUPPLEMENT 1 – PROGRESSING CAVITY PUMPS

PARAMETER	VALUE
Tag No. (s)	P-C061A, P-C062A, P-C063A
Minimum Volumetric Feed Rate (Litres/hour)	4.2
Maximum Volumetric Feed Rate (Litres/hour)	84.8
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	35.0
Minimum Pump Flow Turndown Ratio	21:1
Flow Operating Range (L/day)	100 - 2,050
Pump Operation Duration (h/d)	24
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Commodity	Polymer Solution
Polymer Specific Gravity	1.00-1.14
Polymer Concentration Range (%)	0.1 – 0.5
Driver Minimum (kW)	0.37
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max)	N/A
Motor Suitable for Variable Frequency Drive	Yes
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturers	Moyno Seepex

N/A – not applicable.

SUPPLEMENT 2 – PROGRESSING CAVITY PUMPS

PARAMETER	VALUE
Tag No. (s)	P-C071A, P-C072A
Minimum Volumetric Feed Rate (Litres/hour)	0.50
Maximum Volumetric Feed Rate (Litres/hour)	38.8
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	35
Minimum Pump Flow Turndown Ratio	78:1
Flow Operating Range (L/day)	12 - 950
Pump Operation Duration (h/d)	24
Fluid Temperature Operating Range (◦C)	0.5-25
Solids Concentration Operating Range (%)	N/A
Commodity	Polymer Solution
Polymer Specific Gravity	1.00-1.14
Polymer Concentration Range (%)	0.1 – 0.5
Driver Minimum (kW)	0.37
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max)	N/A
Motor Suitable for Variable Frequency Drive	Yes
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturers	Moyno Seepex

N/A – not applicable.

GRAVITY THICKENER EQUIPMENT

1. GENERAL

1.1 Intention of Section

.1 This Section covers the supply, delivery, site storage, installation, testing, and placement into operation of gravity filter backwash solids thickening equipment and includes motors, gear drivers, bridge structure, filter backwash solids raking arms, feedwell, influent pipe, centre cone scraper, pickets, walkways, centre platform, tube settlers with supports, v-notch weirs, misc. supports anchor bolts for proper installation and operation of the system. In addition, provide control panels (c/w provisions for output to plant SCADA system) and all instrumentation, electrical gear, devices, wiring, conduits, and all accessories and appurtenances specified, indicated on the Drawings, or otherwise required for a complete, properly operating gravity thickening system.

.2 Equipment supplied under this Section shall be fabricated, assembled, and erected in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the Equipment Manufacturer unless exceptions are noted by the Contract Administrator.

.3 Section 11000 - The General Equipment Provisions and Section 11301 – Process Motors shall apply to all equipment supplied under this Section.

.4 Confirm all dimensions with Contract Administrator prior to the manufacturing and installation of the specified equipment.

1.2 Equipment Identification

.1 Nameplates

.1 All equipment and valves supplied with the gravity thickener equipment package shall be provided with permanent metal identification nameplates. Identification used shall be the same as the symbol indicated in the Specifications or on the Drawings and shall be located in a conspicuous place as acceptable to the Contract Administrator.

.2 Manufacturer’s Nameplate

.1 All equipment and valves shall have the Manufacturer’s name, address, and catalogue number on a nameplate securely affixed to the equipment. The nameplate of the distributing agent only will not be acceptable.

.3 Motors

.1 Motors shall have nameplates engraved with bearing and lubricant identity.

1.3 General Equipment Stipulations

.1 Section 11000 - The General Equipment Provisions shall apply to all equipment supplied under this Section.

1.4 Related Work Specified Elsewhere

.1 Instrumentation & Control: Division 17.

1.5 Submittals

.1 As a minimum, submit the following Shop Drawings:

.1 General layout of the equipment showing bolted connections required for installation and removal of equipment sections due to space limitations. All components to be designed for bolted assembly only - no Site welding will be allowed.

.2 Detailed list of materials and which components and material shall be shipped pre-assembled. Weights and physical dimensions shall be indicated for each part, assembly and/or package to be shipped.

.3 Details of sludge raking mechanism and picket assembly.

.4 Detail of influent and effluent launders and supports.

.5 Details of drive mechanism including calculations for gear life according to latest AGMA standards at the continuous torque and speeds specified. Provide calculations for bearing life with B10 bearing life of minimum 100,000 hours.

.6 Details of the torque sensing system.

.7 Motor data.

.8 Torque design data.

.9 Electrical control schematics.

.10 Sludge pit sizing calculations and dimensional Drawing.

.2 Submit certified shop test results for the motor and drive train.

.3 Submit installation manuals and storage instructions indicating specific requirements before shipment of any equipment to the Site.

.4 Bind the installation and O&M manuals with the certified inspection reports on the driving mechanism shop test.

.5 Include maintenance data sheets in the maintenance manuals as specified.

1.6 Spare Parts List

.1 Supply a list of recommended spare parts which would be expected to be required for a period of five (5) years with current prices and anticipated delivery times with submission of O&M manuals.

.2 Supply all spare parts which would normally be required for one (1) year of operation, including as a minimum:

.1 Secondary bearings.

.2 Wiper blades for collection devices.

1.7 Material Standards

.1 Materials and equipment to comply with current Standard Specifications of ASTM Standards except where a higher standard is specifically called for herein.

.2 Miscellaneous metal shall be minimum following standard:

.1 Railings, horizontal and vertical components, to be 65 nominal diameter aluminum pipe, brush finish .\

.2 Railing assembly to consist of verticals to accommodate code loading but at no greater than 1500 O/C max, side mount on stringer/edge beam.

.3 Railing to have top rail at 1070 (centre) above floor surface and one intermediate rail centred.

1.8 Design Standard

.1 Dorr-Oliver Eimco USA, Inc. – Division of GL & V Canada

1.9 Acceptable Manufacturers

.1 Envirodyne Systems Inc.

.2 Wes-Tech Engineering

.3 U.S. Filter/Envirex

.4 Dorr-Oliver Eimco USA, Inc. – Division of GL & V Canada

2. PRODUCTS

2.1 General

.1 The following Specifications do not purport to cover all details entering into the design of the sludge thickening and scraping equipment required, but rather to call attention to certain special features.

.2 Properly balance and align the whole scraper assembly with the drive mechanism so that the operation of the moving parts is free from undue vibration or jerks under the most arduous operating condition.

.3 Design and proportion parts to have liberal strength, stability, and stiffness for the conditions of service.

.4 Supply two complete sets of sludge thickening equipment for installation into the two (2) concrete basins.

.5 Submerged components of the sludge thickening equipment shall be 304 L stainless steel. All weld areas are to be treated with pickling paste and rinsed.

.6 The 100% design torque shall be a minimum of 32.4 kN m (24,000 ft. lbs) for the cage, arms and mechanism support structure.

2.2 Conditions of Service

.1 The unit shall be designed for both continuous and intermittent operation.

.2 The unit shall be housed inside a building. It is essential that assemblies of the various components be designed with regard to the space required in moving into position for installation and future removal for maintenance.

.3 The influent to the thickener will be sludge having a concentration of 0.01 to 1% dry solids by weight.

.4 The design water temperature range is to be taken as 0°C to 25°C and the air temperature range to be taken as 0°C to 30°C.

2.3 Design Criteria for Each Tank

.1	Maximum overflow rate	m/h	0.4
.2	Maximum hourly influent flow rate	m^3/h	150
.3	Maximum daily influent flow rate	m^3/d	1,400
.4	Influent concentration, dry weight solids	%	0.01 – 1.0
.5	Solids Capture Efficiency	%	>90
.6	Thickener Mechanism diameter,	m	12
.7	Thickener Dimensions	m	14.8 x 13.1
.8	Side water depth,	m	6.56
.9	Inlet well depth	m	Min. 2 (TBD by Mfg.)
.10	Influent well diameter	m	3.0 (TBD by Mfg.)

.11	Sludge blanket depth at the centre	m	3.0 (TBD by Mfg.)
.12	Guaranteed Thickened sludge concentration, dry weight solids	%	2.0 - 3.0

2.4 Support Bridge

.1 Design the fixed support bridge to carry a walkway, sludge raking arms, motor and driving mechanism, centre shaft and any other components not specifically mentioned but inherent in the design. Design support and anchor bolts to carry all torsional forces, including the case of jammed raking arms.

.2 Design bridge structure with a limit deflection of $^{1}/_{360}$th of the span under the worst design loading.

.3 Supply aluminum checker plate, minimum 1.2 m wide, walkway conforming to ASTM B632M on top of an aluminum support bridge spanning the tank across the diameter in the orientation shown on the Drawing. Walkway checkered plate, handrail and kick plate shall be supplied from one side of the support bridge to the centre and around the drive. The centre platform shall provide a minimum of 1.2 m clearance all around the drive. The centre platform shall be at minimum 2.5 m x 2.5 m and shall provide working clearance around the drive.

.4 Supply checker plates with 3 mm full face gasket made from 40 A durometer neoprene sheet and fastened down with countersunk stainless steel screws at 200 mm centres maximum. Secure gasket in place on angle frame with a suitable adhesive.

.5 Maximum length of checker plates to be 1 m. Reinforce with stiffeners to limit deflection under a concentrated midspan load of 0.9 kN to $^{1}/_{160}$th of the span.

.6 Supply anodized aluminum double pipe hand-railing conforming to ASTN B21M for the perimeter of the walkway. Top and lower handrail height is to be 1,070 mm and 535 mm, respectively from elevation of walkway. Use 48 mm outside diameter pipe for handrails and posts.

.7 Secure aluminum handrail posts to aluminum plate or combination sleeve and plate by continuous welding. Anchor aluminum plate to walkway channel with stainless steel bolts. Supply full face neoprene gaskets to fit between aluminum plate and aluminum walkway support structure.

.8 Attach aluminum kickplates 100 mm high, 6 mm thick to lower ends of vertical handrail posts.

2.5 Sludge Raking Mechanism

.1 Supply a sludge raking mechanism with two (2) triangular truss-like rake arms connected to the centre vertical shaft in such a manner that the tilt of the arm relative to the sloping tank

floor can be adjusted during installation or maintenance. The supplier is to recommend the slope of the thickener floor.

.2 Supply raking blades with adjustable stainless steel squeegee attached to the rake arms at suitable intervals so that as they transverse the tank floor, sludge will be moved to the conical sludge well at the centre of the tank. Secure blades to the raking arms using stainless steel bolts and locknuts.

.3 Grouting shall be required for required slope formation. Thickener racking mechanism can be used for required slope formation, however all equipment shall be installed in like new condition as a part of the final installation.

.4 Supply vertical pickets on the raking arms to enhance the thickening performance. Extend pickets 3 m up from floor at sludge well.

.5 Supply a centre scraper for the cone sludge well.

2.6 Sludge Thickener Drive Mechanism

.1 The sludge thickener drive mechanism shall consist of an integral motor and primary speed reducer coupled through roller chain and sprockets to a worm shaft and worm which drive the main worm gear, and overload protection system.

.2 The sludge thickener drive primary speed reducer shall be of parallel helical construction with gears manufactured from case hardened steel. The primary speed reducer will drive the main gear reducer through chain and sprockets enclosed in a steel guard. Power transmission devices will be designed with a minimum service factor of 1.5. Units will be supplied with high capacity, anti-friction bearings submerged in oil and splash lubricated. The reducer shall be rated for twenty four (24) hour continuous duty moderate shock load.

.3 The sludge thickener main gear reducer shall consist of a worm and worm gear assembly. The worm gear shall be specifically designed for this application. The worm gear shall be centrifugally cast manganese bronze. The worm shall be AISI 4140/42H grade hardened alloy steel. The gear shall rotate on a precision ball bearing assembly that is completely separate from the worm gear. The precision ball bearing assembly shall be made up of premium alloyed chrome/steel bearing balls and a raceway hardened to at least Rockwell C60 and ground.

.4 The worm and worm gear shall be enclosed in a rigid A-36 steel or ASTM A-48 Class 40A cast iron housing provided with oil fill plugs, and oil drain plugs. The material from which the sludge thickener drive base is constructed shall be of adequate thickness to provide the rigidity necessary for proper bearing support.

.5 The sludge thickener drive mechanism components shall be designed in accordance with referenced standards for twenty four (24) hour continuous duty, moderate shock load. The torque value used in the sizing calculation shall be a minimum continuous torque based upon AGMA and British Standards of 14.91 kN m (11,000 ft. lb.) at .05 rpm. In addition, the sludge thickener drive must be able to sustain a momentary peak torque of 61 kN m

(45,000 ft. lb.). The sludge thickener main gear support bearing shall be designed for a minimum B10 life of 100,000 hours.

.6 The sludge thickener drive shall be designed for the specified continuous torque rating. Continuous torque shall be defined as the minimum torque at which the sludge thickener drive mechanism may operate continuously 24 hours per day, 365 days per year, for 20 years, at the specified maximum sludge thickening and collection arm speed. Worm gearing shall be designed and rated to equal or exceed the specified continuous torque and life. The basis for rating shall be British Standard 721:1963, or other gear design criteria, which includes design values to be applied for materials used, pressure angle, addendum modifications, and allowable stresses with appropriate re-rate for life cycles required. The following design parameters must be included in the drive calculations:

.1 Gear materials, and physical properties

.2 Gear pitch or effective diameter

.3 Actual face width

.4 Tooth pressure angle

.5 Number of gear teeth

.6 Worm material, heat treatment, and finish

.7 All bearings shall run in an oil bath. Oil pumps for lubrication will not be allowed. Provision shall be made for condensate collection below the main bearing and gear to positively prevent the bearings and gears from running in water. Sight glasses and condensate drains for the drive shall be easily accessible without removing plates or structures. Inspection of the completed drive unit shall be accomplished at the sludge thickener Manufacturer's shop, with reports of all tests and certifications of material hardness being made available for review at the Contract Administrator’s request prior to shipment to the job Site.

.8 In no case will units using steady bearings, lower bearings, feedwell bearings, chains, sprockets or any part of the drive unit below the top of walkway beams be allowed.

.9 Drive components will be located via a machined, registered fit or pilot to insure proper alignment. In order to preserve the alignment of key drive components, no welding on the drive will be permitted following final machining operations.

.10 The main gears, main bearings, and drive control that comprise the drive assembly shall be a regularly manufactured in-house product of the sludge thickener manufacturer. Drive assemblies purchased from third party vendors are not acceptable because the drive assembly is a key element in a successful sludge thickener installation.

.11 Electric motors shall be totally enclosed, fan cooled, with a 1.15 service factor, and have bearings with a minimum B10 rating of 50,000 hours. Operating supply will be 600 V, 3 phase, and 60 hz. The motor will be NEMA Design B employing Class F insulation

designed for an ambient temperature of 40°C. Motors must conform to the standards of NEMA.

.12 Supply drive train for single/dual speed operation of the raking arms with a maximum rake tip speed of 0.03 m/sec. The lower speed operation at a tip speed of 0.015 m/sec shall be attainable by simply changing the primary drive pulley selection.

.13 Design gear train to AGMA Standard Number 6034-A87 with a minimum safety factor of 3.0. Design final drive to eliminate any reaction thrust load due to the driving torque.

.14 Employ oil bath lubrication complete with oil fill, drain, and level sight glass easily accessible from the platform walkway.

.15 Supply a high torque switch to provide an alarm to the plant control system with which to energize an alarm light. Set at 80% of machine design torque.

.16 Supply a high-high torque switch to stop the motor at 90% of design torque.

.17 The torque-limiting device should also incorporate a visual load indicator calibrated in percentage of torque and a 4 to 20 mA signal for monitoring by the plant control system.

.18 Supply a shear pin assembly on the drive for fail-safe protection.

.19 Supply equipment guards.

.20 Supply bearings with a B10 life of 100,000 hours minimum as defined by the AFBMA.

2.7 Feedwell

.1 Supply a feedwell constructed of 6 mm thick 304 L stainless steel plate to suit the conditions listed herein.

.2 Support will be provided by brackets attached to the torque shaft. All necessary reinforcing rim angles, stiffeners and supporting brackets shall have a minimum thickness of 6.4 mm (¼ inch).

2.8 Overflow Launder

.1 Overflow launder shall be concrete and is installed by others. Supply adjustable all around stainless steel 316 V-notch overflow weir.

2.9 Influent Pipe

.1 Supply 200 mm diameter stainless steel flanged pipe and suitable pipe hangers for securing underneath the bridge structure. The 200 mm diameter epoxy coated schedule 40 steel influent pipe (c/w ANSI 150 flanges) shall be provided to extend from inside the basin wall to the feedwell.

2.10 Pickets

.1 Provide pickets mounted to the forward edge of each scraper arm. Pickets shall be supported at a higher level using radial arms. The radial arms shall be bolted to the centre cage.

.2 Pickets are to be 50 mm x 50 mm x 6.5 mm angle stainless steel 316, spaced on 600 mm centres. The pickets are to be offset to each side such that the first (right-hand) picket is set at 300 mm from the centre cage. Set the first (left-hand) picket at 600 mm from the centre cage. The end picket and top support are not to be closer that 300 mm from the tank wall.

.3 Terminate the pickets below the influent pipe invert elevation.

3. EXECUTION

3.1 Finishing

.1 Factory finishing shall be in accordance with Manufacturer's Recommendations and Section 11901 – Factory Applied Protective Coatings.

.2 Field finishing and touch up shall be as specified in Section 09901 – Painting and Finishing – Process Mechanical.

3.2 Shop Test

.1 Shop test the completed and assembled drive train to ensure that components have been properly aligned and assembled. The test shall be performed in the presence of the Contract Administrator or his Representative.

3.3 Installation

.1 Installation shall be in accordance with the Manufacturer's printed installation instructions.

.2 Properly balance and align the whole scraper assembly with the drive mechanism so that the operation of the moving parts is free from undue vibration or jerks under the most arduous operating condition.

.3 Coordinate in levelling and alignment of various components On-Site and complete the Work in accordance with the manufacturer's instruction. Manufacturer's Representative shall inspect the installation, check the alignment, check the general operation, and approve the installation as specified.

3.4 Start-up Performance Testing

.1 Prior to setting the raking mechanism in motion, test interlocks, alarms and torque sensing devices including over-torque protection.

.2 Operate the equipment in the dry to ensure there is no sticking or scraping of the scraper blades or malfunctioning of any equipment. Make all adjustments as necessary.

.3 After dry testing, fill the tank to the required operating level with water and at the designed influent rate. Check equipment. Adjust weirs for level.

.4 Instruct plant operating staff in the O&M of the equipment.

.5 Submit certified site test report on the start-up.

3.5 Performance Verification

.1 The performance of the gravity thickener process shall be guaranteed to produce effluent which meets the performance and design requirements stipulated herein at the design flow rate while the WTP is operating within the specified influent parameters.

.2 Overall System Performance Testing

.1 The overall system performance test shall be conducted by competent, authorized representatives of the Equipment Manufacturer who are familiar with operation of the equipment supplied and who have previous satisfactory experience in conducting tests of the type specified. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results.

3.6 Test Procedures

.1 Field performance tests shall be conducted under the service and design conditions specified to demonstrate the systems' ability to consistently perform at the performance and design requirements specified in this Section. The performance tests shall be conducted for at least seven (7) consecutive days and shall commence after the installation is complete and as soon as all system components are operating properly as determined by the Equipment Manufacturer's Representative. The Contractor, City, and the Equipment Manufacturer shall mutually agree in writing when the system is ready for the performance test.

.1 Each performance test shall last twenty four (24) hours a day for at least seven (7) consecutive days.

.2 During the seven day test period, the each system being tested shall be operated at two (2) discrete testing conditions, to mimic the design conditions listed, as follows:

.1 Operation of the basin at 100% of its design capacity;

.2 Operation of the basin at 50% of its design capacity;

.2 Hourly samples shall be taken on both the influent and effluent. Each sample shall be tested for turbidity. Laboratory costs of testing shall be paid by the Contractor.

.3 During performance testing, the Equipment Manufacturer's Representative shall be allowed to adjust the chemicals provided within the dosage ranges specified in order to optimize the performance of the equipment.

.4 The data to be determined in each test shall include, but not be limited to:

.1 Influent flow rate

.2 Water temperature

.3 Chemical dosage

.4 Sludge concentration

.5 The performance requirements of the process shall be considered to be fully met when the system produces an effluent within the specified limits with the basin operating at 100% of its design capacity 100% of the time for a five (5) consecutive calendar day period. If more than a seven (7) day test period is required to achieve this objective, then the test will be extended beyond the seven (7) day period until the limit is achieved.

.6 Should the Contractor be unable to produce an effluent quality within the limits previously set forth during a test period due to any malfunction of the system, equipment, or plant process, or if the influent characteristics exceed the limits previously set forth, the test period shall begin again. The procedures shall be continued until such time as five (5) consecutive calendar days have been accumulated.

3.7 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct the Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by competing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 The minimum periods of Site attendance are identified in the following table along with the form to be completed on each of these trips.

.4 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train O&M staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

GRAVITY THICKENER EQUIPMENT

Item	Description	Total number of days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	1	102
4	Assistance in Equipment Performance Testing	7	103
5	Operator and Maintenance Training	4	T1

END OF SECTION

CENTRIFUGAL AIR BLOWER

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American Society for Testing and Materials (ASTM):

.1 A48, Gray Iron Castings.

.2 A576, Steel Bars, Carbon, Hot-Wrought, Special Quality.

.3 B62, Composition Bronze or Ounce Metal Castings.

.4 B148, Aluminum-Bronze Sand.

.5 B584, Copper Alloy Sand Castings for General Applications.

.2 American Iron and Steel Institute (AISI):

.1 Type 416 Stainless Steel.

.2 Type 1035 Steel.

.3 Type 4140 Alloy Steel.

.3 National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.2 Description:

.1 This Section specifies the general requirements for the supply and installation of centrifugal blowers to provide air scour supply to the filter system during air/water wash and air only process steps.

1.3 Submittals

.1 Shop Drawings – Refer to Section 01300:

.1 Make, model, weight, and power of each equipment assembly.

.2 Complete catalog information, descriptive literature, specifications, dimensions, cross-sectional details and identification of materials of construction.

.3 Layout of blower bases, blowers, electric motors, silencers, vibration isolators and anchor bolts.

.4 Details of expansion pieces including list of materials.

.5 Sectional details of the check valves, and blower including list of materials.

.6 Performance data curves showing head, capacity, power, and blower efficiency over the entire operating range of the blower, from shut off to maximum capacity. Indicate separately the design points, head, capacity, power demand, and overall efficiency.

.7 Detailed mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.8 Power and control wiring diagrams, including terminals and numbers.

.9 Complete motor nameplate data, as required by NEMA, motor Manufacturer, including any motor modifications.

.10 Certified non-witnessed performance test to ASME PTC-10 standards of one blower of units to be delivered. Provide certified shop test results of vibration measurements of both units for blower and motor.

.11 Details of storage and offloading requirements.

.12 Factory finish system.

.2 Quality Control Submittals:

.1 Factory Functional and Performance Test Reports and Log.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions, including blower specific vibration and alignment tolerances.

.5 Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Provide an Operation and Maintenance Manual and Maintenance Summary in conformance with the requirements of Division 1, General Requirements, and Section 01730, Operation and Maintenance Manuals

1.4 Spare Parts

.1 Furnish for each size of blower:

.1 Complete set of bearings

.2 Four pleated felt elements for the intake filter-silencer.

.3 One complete set of any special tools required to dismantle the blower.

2. PRODUCTS

2.1 General

.1 Coordinate blower requirements with drive Manufacturer and be responsible for blower and drive requirements.

.2 Provide workmanship, materials and methods of construction that conform to best practice and highest standard of the industry.

.3 Supply and install units complete in all particulars and ready for operation.

.4 Design and proportion all parts to have liberal strength, stability and stiffness and to be specially adapted to the conditions of service.

.5 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid.

.6 The supply of centrifugal air blowers under this Section shall come from a single Manufacturer.

2.2 Blowers

.1 Supply and install centrifugal air blowers as described hereinafter.

.2 Supply centrifugal blowers of the vertically split, multi-stage, type with high strength aluminum alloy impellers mounted on a polished carbon steel shaft.

.3 Supply blower housing of cast iron sections clamped between cast iron heads by steel tie rods. Heads shall be provided with flanged connections for inlet and outlet piping.

.4 Supply cast or fabricated aluminum alloy impellers of the blade-type keyed and locked to the shaft.

.5 Statically and dynamically balance each impeller and dynamically balance the complete rotating assembly. Design the rotating assembly to operate at least 20 percent removed from first critical speed.

.6 Mount anti-friction type bearings sized for continuous duty and long life at both ends of each shaft. Provide bearings of standard stock SKF, MRC or approved equal, readily available for replacement. Provide oil-lubricated bearings with atmospheric type constant level oilers.

.7 Select bearings on the basis of B-10 life as required by the AFBMA at rated conditions of service of at least 100,000 working hours. Provide the bearing housing external to the blower case, readily accessible for inspection and bearing replacement without disconnecting any part of the piping or disassembling the machine.

.8 Provide standard mechanical shaft seal where the rotor shaft passes through the inlet and outlet heads to prevent leakage of air. Provide seal that can be replaced or opened for inspection without disconnecting the suction or discharging piping. Install labyrinth-type seals between the stages of the blowers to prevent air leakage.

.9 Use flexible couplings to connect the motor to the blower, sized according to the output kilowatt of the motor and the speed of the unit. Provide couplings that can be disengaged without shifting the coupling hubs or the shafts.

.10 Provide TEFC induction motors for driving the blower as specified in Section 11301 – Process Motors.

.11 Supply surge protection components for installation in the MCC as described in Division 16.

.12 Supply local control panels as described in Section 16991 – Control Panels.

.13 Supply all equipment, instrumentation, control panel and other components as a Vendor Package for installation by Contractor as per contract drawings. Air Scour (AS) 316 Stainless Steel Piping and insulation is supplied and installed by Contractor as specified in Division 15.

.14 Supply all instrumentation in accordance with Division 17 requirements.

.15 Provide vibration isolation pads for blower baseplate to be mounted on concrete base.

2.3 Supplements

.1 Blower data sheets and any other specific requirements are attached to this Section as supplements.

.2 Refer to Section 11300 – Process Pump General Requirements, and 11301 – Process Motors for additional requirements.

2.4 Inlet Filter Silencers

.1 For each blower, provide the following units:

.1 One 400 mm intake filter-silencer and corresponding pleated felt element.

.2 One differential pressure indicator on the intake filter-silencer with 4-20 ma analog signal output.

.2 Acceptable Manufacturers:

.1 Universal Silencer, Model CCS

.2 Approved equal

2.5 Inlet In-line Silencer

.1 For each blower, provide a 300 mm nominal diameter in-line silencer.

.2 Acceptable Manufacturer:

.1 Universal Silencer

.2 Approved equal

2.6 Expansion Joints

.1 Provide expansion joints on inlet and outlet of blowers to be of the single arch type, canvas reinforced rubber, with galvanized steel retaining rings of suitable size.

.2 Provide expansion joints suitable for inlet and outlet air temperatures and pressures.

2.7 Check Valves

.1 Provide wafer-style air check valves on the discharge of each blower.

.2 Valves to be specially fitted for air with a maximum resistance of 0.4 kPa at maximum airflow rate from the blowers.

.3 Provide valves to be mounted between two ANSI 125/150 pound flanges.

.4 Clapper to be nonpulsating, nonclattering type with stainless steel pin and spring.

.5 Valves to have cast iron bodies, with a springless, seatless design. Sealing members to be high quality silicone and rated for service up to 150 °C.

2.8 Baseplate

.1 Mount equipment and driver on a common baseplate in a compact arrangement.

.2 Provide equipment baseplates of heavy cast iron or of welded structural steel section at least 13 mm thick. Provide mounting plates at least 20 mm thick for mounting equipment and driver. Machine surfaces for mounting equipment and driver to an arithmetical average roughness height of less than 3 microns.

.3 Provide closed baseplates suitable for grouting. Provide grout holes, vent holes and anchor bolt holes in the baseplates.

.4 Provide jack bolts with fine thread to allow two directional horizontal movement of the motor for realignment purposes.

.5 Provide 316 stainless steel anchor bolts designed to restrain the blower from movement. Provide pipe sleeves for anchor bolts not less than 2 1/2 times the diameter of the anchor bolts.

2.9 Accessories

.1 Equipment Identification Plate: 1.6 mm stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kg.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment Manufacturer.

2.10 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be by the Contractor in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Level base by means of steel wedges (steelplates and steel shims). Wedge taper not greater than 6 mm per 0.3 m. Use double wedges to provide a level bearing surface for the blower and driver base. Accomplish wedging so that there is no change of level or springing of the baseplate when the anchor bolts are tightened.

.2 Adjust blower assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

.3 After the blower and driver have been set in position, aligned, and shimmed to the proper elevation, grout the space between the bottom of the baseplate and the concrete foundation with a poured, nonshrinking grout. Remove wedges after grout is set and pack void with grout.

.4 Connect suction and discharge piping without imposing strain to blower flanges.

.5 Anchor Bolts: Accurately place using equipment templates. All mounting brackets, bases, beams, hardware and stabilizers shall be Type 316 stainless steel and shall be supplied by the Manufacturer

3.2 Field Finishing by Contractor

.1 Provide field finishes with touch ups as specified in Section 09901 - Painting.and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each blower.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency in any plane, peak-to-peak vibration velocities in excess of 6 mm/sec.

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced.

.3 Flow Output: Measured by plant instrumentation.

.4 Operating Temperatures: Monitor bearing areas on blower and motor for abnormally high temperatures.

.2 Performance Test: In accordance with operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, shall be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	4	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer’s Representative and as indicated in the Contract Documents.

.2 The Manufacturer’s Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Air scour blowers: BLW-F010A, BLW-F020A

END OF SECTION

CENTRIFUGAL AIR BLOWER

SUPPLEMENT 1 – AIR SCOUR BLOWERS

PARAMETER	VALUE
Tag No. (s)	BLW-F010A, BLW-F020A
Local atmospheric pressure, kPa	98
Min. inlet air temperature, °C	5
Max. inlet air temperature, °C	25
Design Point Flow Capacity (Sm^3/h) (20°C, 1 atm, 36% RH)	5180
Design Point Discharge Pressure (kPa) (excludes losses internal to blower)	70.3
Discharge Air Temperature (◦C)	120
Blower Room Finished Floor (Geodetic) (m)	245.000
Centreline Blower Discharge (Geodetic) (m)	247.700
Driver Maximum (kW)	186
Driver Voltage (V/phase/frequency)	575/3/60
Speed (max)	3550
Motor Suitable for Variable Frequency Drive	N/A
Minimum Blower Efficiency at Design Point (%)	65
Acceptable Manufacturers	Continental Houston Service Industries (HSI) Gardner Denver

N/A – not applicable.

VERTICAL IN-LINE CENTRIFUGAL PUMPS

1. GENERAL

1.1 Related Work

.1 Pumps shall be in compliance with the appropriate sections of the following codes:

.1 NSF International, Standard 61 - Drinking Water System Components.

.2 American Gear Manufacturers Association (AGMA).

.3 American Institute of Steel Construction (AISC).

.4 American Iron and Steel Institute (AISI).

.5 American Bearing Manufacturers' Association (ABMA).

.6 American Society of Mechanical Engineers (ASME).

.7 American National Standards Institute (ANSI).

.8 American Society for Testing and Materials (ASTM).

.9 Canadian Electrical Code (CEC).

.10 Canadian Standards Association (CSA).

.11 Electrical and Electronic Manufacturers Association of Canada (EEMAC).

.12 Electrical Safety Authority (ESA).

.13 Instrument Society of America (ISA).

.14 National Electrical Code (NEC).

.15 National Fire Protection Association (NFPA).

.16 Steel Structures Painting Council (SSPC).

.17 Manitoba Building Code.

.18 Canadian Plumbing Code (CPC).

.19 Occupational Safety & Health Act (OSHA).

1.2 Definitions

.1 Terminology pertaining to pumping unit performance and construction shall conform to Section 11300 – Process Pumps General Requirements, and ratings and nomenclature of the Hydraulic Institute Standards.

1.3 Contractor Submittals

.1 Shop Drawings:

.1 Make, model, weight, horsepower, and cross sectional details and colour brochures of each equipment assembly.

.2 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.

.3 Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.

.4 Pump maximum downthrust or upthrust in pounds.

.5 Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.6 Power and control wiring diagrams, including terminals and numbers.

.7 Complete motor nameplate data, as defined by NEMA, motor Manufacturer, and including any motor modifications.

.8 Factory finish system.

.9 Size, length and spacing of anchor bolts or attachment to the foundations or supports.

.10 External utility requirements: air, water, power, etc. for each component.

.11 Provide certified shop test results for pump and motor assembly vibration levels at design operating point.

.2 Quality Control Submittals:

.1 Factory and field performance test reports and logs.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions, including pump specific vibration and alignment tolerances.

.5 Suggested spare parts list to maintain the equipment in service for a period of five (5) years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Provide an operation and maintenance manual and maintenance summary in conformance with the requirements of Division 1, General Requirements, and Section 01730 – Operation and Maintenance Manuals.

1.4 Required Spare Parts and Special Tools

.1 Furnish for each size of pump:

.1 One (1) complete set of packing.

.2 One (1) complete set of bearings.

.3 One (1) complete set of gaskets and O-ring seals.

.4 One (1) complete of set of rod washers.

.5 One (1) complete set of keys, dowels, pins, etc.

.6 One (1) stator.

.7 One (1) rotor.

.8 One (1) connecting rod with pair of universal joint(s), as required by pump type.

.9 One (1) complete set of any special tools required to dismantle pump.

2. PRODUCTS

2.1 General

.1 Refer to Section 11300 – Process Pumps General Requirements.

.2 Refer to Section 11301 – Process Motors.

.3 All pumps and motors are to be designed for indoor service.

.4 Supplements at the end of this Section list Acceptable Manufacturers, and where specified, models. This acceptance does not in any way relieve the Contractor or Manufacturer from providing models that meet all requirements of these specifications, and that fit within the piping and equipment layout shown in the contract drawings. The Contractor shall have the Manufacturer confirm that equipment meets all requirements of the specifications before including the price in their bid."

.5 The supply of vertical in-line centrifugal pumps under this Section shall come from a single Manufacturer.

2.2 Code Requirements

.1 The equipment shall meet or exceed the requirements of the latest revision of the ANSI B73.1 or ANSI B73.2 Standard and the Standards of the Hydraulics Institute.

.2 The motor drivers shall be in accordance with the latest revision of the EEMAC

.1 Code. All electrical equipment shall be CSA approved.

2.3 Pump Design and Selection

.1 General

.1 The style and type of centrifugal pumps shall be selected on the basis of the service, duty conditions, and installation requirements specified on the Vertical In-Line Centrifugal Pump Data Sheets.

.2 Operating conditions specified on the Vertical In-Line Centrifugal Pump Data Sheets are at the centerlines of the suction and discharge flanges.

.3 Pumps designed with mechanical seals shall combine the use of throat bushings, wearing rings, back pump out vanes, shaft sleeves, and flushing line arrangement to ensure a stuffing box pressure in excess of suction pressure; ensure that the temperature and pressure in the stuffing box prevents vaporization; provide a continuous flow through the seal chamber.

.4 The head curve for the pump shall be continuously rising from the maximum capacity point to the minimum. Pumps with a stable curve rising to the shut-off flow are preferred.

.5 The pump shut-off head shall be approximately 110%, but not exceed 120%, of the head at the RATED capacity.

.6 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.4 Motor Driver

.1 Motors shall be as specified on the individual data sheets and as specified in Section 11301 – Process Motors.

.2 The motor nameplate horsepower rating shall not be exceeded at any head-capacity point on the pump curve.

.3 TEFC means "totally enclosed, fan cooled."

2.5 Couplings

.1 The spacer coupling shall be sized to permit removal of the coupling, bearings, seal and/or rotor, without disturbing the driver or the suction and discharge piping.

.2 Coupling guards shall be provided in accordance with provincial occupational health and safety regulations.

2.6 Bearings

.1 The bearings shall be Manufacturers standard grease or oil-lubricated, anti-friction bearings. Inboard bearings shall carry radial thrust only.

2.7 Mechanical Seals and Packing

.1 Mechanical seals shall be furnished on all pumps (except as noted on the pump data sheets), selected by the Manufacturer for the specified service.

.2 Seal plates shall be used to identify cooling, flushing, vent, and drain connections.

.3 Minimum flushing fluid tubing size shall be 10 mm.

2.8 Accessories

.1 Non-ferrous Grout: pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, Grace in Pakt Grout, minimum compressive strength 35 MPa.

.2 Provide all mounting brackets and wall braces if required to meet vibration tolerances.

2.9 Equipment Performance

.1 The pump shall operate free of cavitation over the entire operating range of the head-capacity curve provided by the Manufacturer for the specified operating conditions

2.10 Factory Finishing

.1 Prepare, prime, and finish coat in accordance with Section 11901 – Factory Applied Protective Coatings.

3. EXECUTION

3.1 Installation by Contractor

.1 Installation will be by the Contractor in accordance with the Manufacturer's printed installation instructions. Installation includes but is not limited to:

.1 Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

.2 Connect suction and discharge piping without imposing strain to pump flanges.

3.2 Field Finishing by Contractor

.1 Provide field finishing with touch ups for equipment as specified in Section 09901, Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Functional Tests: Conduct on each pump.

.1 Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

.2 Vibration Test:

.1 Test with units installed and in normal operation, and discharging to the connected piping systems at rates between the low discharge head and high discharge head conditions specified, and with the actual building structures and foundations provided shall not develop at any frequency or in any plane, peak-to-peak vibration amplitudes in excess of 0.2 mm or velocities in excess of 6 mm/sec..

.2 If units exhibit vibration in excess of the limits specified adjust or modify as necessary. Units that cannot be adjusted or modified to conform as specified shall be replaced**.**

.3 Flow Output: Measured by WTP instrumentation and storage volumes.

.4 Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

.2 Performance Test: In accordance with Hydraulic Institute Standards and/or more stringent requirements as described herein for operating conditions indicated in supplemental equipment data sheets.

3.4 Manufacturer's Representative Field Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	2	102
4	Assistance in Equipment Performance Testing	6	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data Sheets:

.1 Ozone Cooling Water Supply Pumps: P-O401A, P-O402A, P-O403A.

.2 CCT Drain Pump: P-F055A

.3 Nozzle Injector Water Supply Pumps: P-J701A, P-J702A

END OF SECTION

SUPPLEMENT 1 – OZONE SYSTEM COOLING WATER PUMPS

PARAMETER	VALUE
Tag No. (s)	P-O401A, P-O402A, P-O403A
Maximum Flow Rate (litres/sec)	16.0
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	20.0
Minimum Pump Flow Turndown Ratio	N/A
Pump Operation Duration (h/d)	24
Fluid Temperature Operating Range (◦C)	0.5 – 26
Solids Concentration Operating Range (%)	N/A
Commodity	Filtered Water
Solids Concentration Range (%)	N/A
Driver Maximum (kW)	5.5
Driver Voltage (V/phase/frequency)	575/3/60
Motor Suitable for Variable Frequency Drive	N/A
Speed (max rpm)	3,600
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturer	Grundfos Model CR 45-1-1 Flowserve Mark 3 ITT Allis Chalmers Aurora

N/A – not applicable.

SUPPLEMENT 2 – CHLORINE CONTACT TANK DRAIN PUMP

PARAMETER	VALUE	
Tag No. (s)	P-F055A	
Design Point Flow Capacity (L/s)	Primary: 38.0	Secondary: Minimum 20.0
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	Primary: 7.2	Secondary: Estimated 9 to 10.8
Minimum Pump Flow Turndown Ratio	N/A	
Pump Operation Duration (h/d)	1.0	
Fluid Temperature Operating Range (◦C)	0.5 - 25	
Solids Concentration Operating Range (%)	N/A	
Commodity	Filtered Water	
Solids Concentration Range (%)	N/A	
Driver Maximum (kW)	12	
Driver Voltage (V/phase/frequency)	575/3/60	
Motor Suitable for Variable Frequency Drive	N/A	
Speed (max rpm)	3,600	
Minimum Pump Efficiency at Design Point (%)	65	
Acceptable Manufacturer	Grundfoss, Model CRN 90-1-1 Aurora, Model 382-BF 6X6X9 ITT Allis Chalmers Flowserve	

N/A – not applicable.

SUPPLEMENT 3 – NOZZLE INJECTOR WATER SUPPLY PUMPS

PARAMETER	VALUE
Tag No. (s)	P-J701A, P-J702A
Maximum Flow Rate (litres/sec)	8.0
Design Point Total Dynamic Head (TDH) (m) (excludes losses internal to pump)	15.0
Minimum Pump Flow Turndown Ratio	N/A
Pump Operation Duration (h/d)	24
Fluid Temperature Operating Range (◦C)	0.5 - 25
Solids Concentration Operating Range (%)	N/A
Commodity	Filter Water
Solids Concentration Range (%)	N/A
Driver Maximum (kW)	2.2
Driver Voltage (V/phase/frequency)	575/3/60
Motor Suitable for Variable Frequency Drive	N/A
Speed (max rpm)	3,600
Minimum Pump Efficiency at Design Point (%)	80%
Acceptable Manufacturer	Grundfos Model CR 32-1-1 Flowserve Mark 3 ITT Allis Chalmers Aurora

N/A – not applicable.

CHEMICAL INJECTION NOZZLES

1. GENERAL

1.1 Work Included

.1 Chemical injection shall be used to inject filtered water and sodium hypochlorite into the Chlorine Contact Tank Effluent Conduit.

1.2 Contractor Submittals

.1 Shop Drawings:

.1 Complete list of all system components to be provided

.2 Make, model, weight, and cross sectional details and colour brochures of each equipment assembly.

.3 Complete catalog information, descriptive literature, Specifications, and identification of materials of construction.

.4 Detailed Drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.

.2 Quality Control Submittals:

.1 Factory Functional and Performance Test Reports.

.2 Special shipping, storage and protection, and handling instructions.

.3 Manufacturer's printed installation instructions.

.4 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.5 Operation and maintenance (O&M) manual.

2. PRODUCTS

2.1 Nozzles

.1 Chlorine Contact Tank Effluent Conduit Nozzles:

.1 Quantity: Two, located as shown on Drawings

.2 Design Condition: 475 litres per minute (Lpm) at 125 kPa, Upstream injection of 0.8% Sodium Hypochlorite solution that is diluted in water. Maximum total flow is approximately 600 Lpm.

CHEMICAL INJECTION NOZZLES

.3 Type: 65 mm diameter nozzle, full cone spray patter with uniform distribution, 120-degree spray angle, constructed of Hastelloy C; two 50 mm diameter Hastelloy C pipes with socket weld unions, butt –welded onto nozzle with full welds, extending to a point 100 mm from the nozzle orifice and butt-welded so no flow can pass between the 50 mm diameter pipes. Ammonia pipe shall have 4 mm diameter orifice and Caustic pipe shall have 12 mm diameter orifice. Orifices shall face away from the nozzle orifice. Provide male thread on 65 mm diameter nozzle

.4 Acceptable Manufacturer and Product: Bete 100 mm diameter nozzle number SC80W or approved equal.

3. EXECUTION

3.1 Installation

.1 Install in strict accordance with Manufacturer's installation instructions and recommendations.

3.2 Manufacturer's Services

.1 See Section 01650 - Equipment Installation

END OF SECTION

FACTORY APPLIED PROTECTIVE COATINGS

1. GENERAL

1.1 Work Included

.1 Supply and application of all factory applied prime coats or factory applied finish coats, where specified, for equipment and products supplied by the Contractor.

1.2 Submissions

.1 With the equipment Shop Drawings, submit details of the coating systems to be applied.

1.3 Quality Assurance

.1 This Specification is intended to be a minimum reference standard. The Contractor may submit for review alternative coating systems for specific items of equipment which provide equal or better corrosion protection and maintenance service than those specified herein.

2. PRODUCTS

2.1 Surface Preparation

.1 Immersion Service: After degreasing, dry blast all ferrous components to a white metal finish in accordance with Steel Structures Painting Council (SSPC)-SP5 to a degree of cleanliness in accordance with National Association of Corrosion Engineers (NACE) No. 1 and obtain a 1.3 mm (50 micron) blast profile.

.2 Non-immersion Service: After degreasing, dry blast all ferrous components to a near white finish in accordance with SSPC-SP10 to a degree of cleanness in accordance with NACE No. 3 and obtain a 1.3 mm (50 micron) blast profile.

2.2 Coating

.1 Provide 3 coats of polyamide epoxy coating, NSF 61 approved potable grade, 0.08 mm (3 mils) minimum dry film thickness per coat.

2.3 Assembly

.1 For items which are to be bolted together before shipment, clean surfaces and coat before the parts are assembled.

.2 Continuous weld all welded connections, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution. Rinse and thoroughly dry before the prime is applied.

.3 Where dissimilar metals are mated insulate the mating surfaces from one another to provide protection against corrosion. Insulate bolts, nuts, washers, and rivets in a similar manner.

.4 Use 304 stainless steel or better for all nuts, bolts, washers and similar fittings for immersion service. For non-immersion service, use 304 stainless or zinc or cadmium plated nuts, bolts, washers, and similar fittings. Clean and coat the inner face of non-threaded bolt holes as required for other surfaces.

3. EXECUTION

3.1 General

.1 Apply coatings in accordance with coating manufacturer's instructions.

3.2 Inspection

.1 Notify the Contract Administrator two (2) weeks before commencing the protective coating to permit the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.3 Protection

.1 Protect all coated equipment adequately against damage, dust, moisture, and scratching during shipment, off-loading and storage on-site. If, in the opinion of the Contract Administrator, the coating is damaged during shipment to the extent that touch up would not be satisfactory, return and re-coat the equipment at the Contractor's cost.

.2 Make good damage to coatings occurring at any time prior to the application of any further coatings.

3.4 Application Conditions

.1 Apply all factory applied coatings under controlled conditions, in a dust-free atmosphere at a temperature of between 10 and 20°C, and a relative humidity should not exceed 80%.

END OF SECTION

FIRE DETECTION AND ALARM

1. GENERAL

1.1 Scope of Work

.1 Design, supply and install a complete and working fire detection and alarm system including but not limited to alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators and wiring.

.2 Conduit and raceway are supplied and installed by Division 16.

1.2 References

.1 The following is a list of standards which may be referenced in this section:

.1 Institute of Electrical and Electronics Engineers (IEEE): C62.41, Surge Voltages in Low-Voltage AC Power Circuits.

.2 National Fire Protection Association (NFPA):

.1 72, National Fire Alarm Code.

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.3 101, Code for Safety to Life from Fire in Buildings and Structures.

.3 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Telecommunications Industry Association (TIA):

.1 232, Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange.

.2 485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.

.5 Underwriters Laboratories of Canada (ULC):

.1 S524-M, Standard for the Installation of Fire Alarm Systems.

.2 S525, Standard for Audible Signal Devices for Fire Alarm Systems.

.3 S526, Standard for Visual Signal Devised for Fire Alarm Systems.

.4 S527, Standard for Control Units for Fire Alarm Systems.

.5 S528, Standard for Manual Pull Stations for Fire Alarm Systems.

.6 S529, Standard for Smoke Detectors for Fire Alarm Systems.

.7 S530, Standard for Heat Activated Fire Detectors for Fire Alarm Systems.

.8 S536, Inspection and Testing of Fire Alarm Systems.

.9 S537-M, Standard for the Verification of Fire Alarm Systems.

.10 S541, Standard for Speakers for Fire Alarm Systems.

.11 S553, Manual Pull Stations for Fire Alarm Systems, Including Accessories.

.6 Underwriters Laboratories, Inc. (UL):

.1 217, Single and Multiple Station Smoke Alarms.

.2 228, Door Closures-Holders, With or Without Integral Smoke Detectors.

.3 268, Smoke Detectors for Fire Protective Signaling Systems.

.4 286A, Smoke Detectors for Duct Application.

.5 464, Audible Signal Appliances.

.6 497B, Protectors for Data Communication and Fire Alarm Circuits.

.7 864, Control Units for Fire-Protective Signaling Systems.

.8 1449, Standard for Transient Voltage Surge Suppressors.

.9 1480, Speakers for Fire-Protective Signaling Systems.

.10 1604, Electrical Equipment for Use in Class I and Class II, Division 2, and Class III Hazardous (Classified) Locations.

.11 1638, Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.

.12 1971, Signaling Devices for the Hearing Impaired.

1.3 Definitions

.1 Addressable: A fire alarm system component with a unique identification that can have its status individually identified or that is used to individually control other functions.

.2 AHJ: Authority Having Jurisdiction.

.3 BMS: Building Management System.

.4 CAD: Computer Aided Design.

.5 Coded: Audible or visible signal that conveys information about alarm event. Examples are, number of rings of a bell or flashes of a strobe. This could be used to convey location or type of alarm.

.6 dB: Decibels.

.7 DXF: Drawing Interchange Format.

.8 ECP: Environmental Control Panel.

.9 FACP: Fire Alarm Control Panel.

.10 HVAC: Heating, Ventilating, and Air Conditioning.

.11 I/O: Input/Output.

.12 LCD: Liquid Crystal Display.

.13 LED: Light-Emitting Diode.

.14 MOV: Metal Oxide Varistor.

.15 RAM: Random Access Memory.

.16 SOM: Sequence of Operations Matrix.

.17 Zone: A defined area within the protected premises. A zone is an area from which an alarm signal can be received or an area to which a signal can be sent.

1.4 Design Requirements:

.1 Contract Drawings show location of fire alarm panel, annunciator panel, emergency alarm components, fire suppression system switches. Other component locations and quantities shall be determined by Contractor and shall be included as part of their design. This includes, but is not limited to, smoke detectors, heat detectors, manual pull stations, duct detectors, notification appliances and fire pump system devices. Design and installation shall meet requirements of the local AHJ.

.2 Contract Drawings show location of fire alarm system components.

.3 Design, coordinate, and provide system in accordance with Section 01600, Material and Equipment.

.4 Design conduit layout and wiring interconnection of devices specified herein and for interconnection of flow and supervisory switches and alarm bells specified in Section 13930, Fire Suppression System.

.5 Design conduit layout and wiring interconnection of devices related to the fire pumps specified in Section 13930, Fire Suppression System.

.6 Coordinate, and include in design, requirements for interfacing with HVAC system.

.7 Coordinate design and installation with elevator installation.

.8 Equipment suitable for addressable fire alarm system.

1.5 Performance Requirements:

.1 Actuation of alarm (smoke or heat detector, flow switch, or other normally open initiating device contact) or trouble (trouble or supervisory switch) shall cause audible and visual indications of alarmed devices on FACP display, and on remote annunciator.

.2 Allow for connection of three (3) remote buildings with subpanels to the FACP. Provide for common alarm or trouble signal to light appropriate zone lamp at master FACP.

.3 Master FACP shall transmit common alarm or trouble signal to plant control panel.

.4 Actuation of duct smoke detectors shall send signal (contact closure) to BMS to shut off HVAC equipment and send a Supervisory Alarm to the FACP. Fan equipment shall shutdown in accordance with Section 15900, HVAC Instrumentation and Controls-General. Contact output to BMS shall be rated for no less than 5A, 250V ac.

.5 Actuation of sprinkler flow switch and sprinkler system low pressure condition shall alarm at panel.

.6 Fire pump system status and trouble condition shall be indicated at the FACP.

.7 Discharge of sprinklers in elevator shaft or machine room shall send supervised trip signal to elevator controller/circuit breaker to trip on actuation of temperature detector installed adjacent to sprinkler head and with lower setting.

1.6 Submittals

.1 Action Submittals:

.1 Descriptive product information for each individual system component including manufacturer’s name, model number, ratings and power requirements..

.2 Dimensional drawings of panels and associated equipment.

.3 Itemized bill of material.

.4 Operating and programming instructions.

.5 Control panel configuration and module data.

.6 Complete point-to-point wiring diagrams of system and device interconnection. Identify spare connection points.

.7 Alarm initiating, indicating, and supervisory device electrical data.

.8 Annunciator configuration and module data.

.9 Plans showing device and panel locations as well as conduit and cable sizes. Prepare drawings and diagrams on drawing sheets of uniform size without extraneous information. Marked up electrical, HVAC, lighting or similar drawings or copies of catalog data sheets are not acceptable in lieu of required drawings or diagrams.

.10 Sequence of Operation Matrix.

.11 Battery sizing calculations.

.12 Supervisory power requirements for equipment.

.13 Alarm power requirements for equipment.

.14 Power supply rating justification showing power requirements for system power supplies.

.15 Voltage drop calculations for wiring runs, demonstrating worst case condition.

.16 Conduit fill calculations.

.17 Sample warranty.

.18 Recommended types and quantities for spare parts.

.19 For each system's control panel, provide written schedule of active and spare addresses provided on each addressable circuit.

.2 Informational Submittals:

.1 Experience and qualifications of firm(s) proposed to design and install system.

.2 Certifications documenting service technician's training. Certification shall indicate name of individual, training, dates, systems qualified, and current status.

.3 Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.

.4 Code-enforcement authority approval letter.

.5 Factory test reports.

.6 Operation and Maintenance Data as specified in Section 01730, Operation and Maintenance Manuals.

.7 Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of ULC-S524, NFPA 72, manufacturer's recommendations, and AHJ.

.8 Written documentation for logic modules as programmed, for system operation, with matrix showing interaction of input signals with output commands.

.9 System program hard copy and CD-ROM showing system functions, controls, and labeling of equipment and devices.

.10 Documentation of system voltage, current, and resistance readings taken during system installation and testing.

.11 System record drawings and wiring details including one set of reproducible masters and drawings on CD-ROM in a DXF format suitable for use in a CAD drafting program.

.12 NFPA 72, Record of Completion: Submit to Contract Administrator and code enforcement authorities.

.13 NFPA 72, Inspection and Testing Form: Submit to Contract Administrator and code enforcement authorities.

1.7 Quality Assurance

.1 Qualifications:

.1 Technician with minimum of Engineering Technologist Certification for fire alarm systems or professional engineer registered in Province of Manitoba shall be available onsite.

.2 Service technician shall be formally trained by manufacturer.

.2 Regulatory Requirements: Submit Shop Drawings and system design calculations for approval to the following code enforcement authorities.

.1 Local and national building codes.

.2 Authority Having Jurisdiction (AHJ).

2. PRODUCTS

2.1 Manufacturers

.1 Materials, equipment, and accessories specified in this section shall be products of:

.1 Siemens Building Technologies.

.2 Simplex/Grinnell.

.3 Notifier Fire Systems.

.4 Edwards Systems Technology.

2.2 General

.1 Material and equipment shall be standard products of their respective manufacturers, and shall be of a model that has been in production for not less than 3 years. Equipment shall be supported by a service organization that is, in the opinion of Contract Administrator, reasonably convenient to Site.

.2 Contractor shall become familiar with details of Work, verify dimensions in field, and revise conduit and equipment locations to avoid obstructions and allow installation of new equipment.

.3 Contractor shall not begin system installation prior to receiving written approval of Shop Drawings from Contract Administrator.

.4 Electrical equipment shall be CSA Approved.

2.3 UL/ULC Compliance

.1 Products manufactured within scope of Underwriters Laboratories, Inc. of Underwriters Laboratories of Canada shall conform to UL/ULC Standards and have an applied UL/ULC listing mark.

.2 Equipment shall be UL/ULC listed in accordance with requirements of NFPA.

2.4 Service Conditions

.1 Altitude: Not greater 260 m above sea level.

.2 Ambient Temperature:

.1 Maximum 40°C.

.2 Minimum 10°C.

.3 Equipment shall be fully rated without derating for these conditions.

2.5 Posted Operating Instructions (POI)

.1 POIs shall be prepared on full size drawing sheets.

.2 POIs shall be framed in extruded metal frames, mounted under glass and shall be water/weather resistant. Instructions shall be permanently mounted on reserved wall area in space shown on Drawings.

.3 POIs shall include:

.1 Facility floor plans showing location of fire equipment and devices with coordinated identification. Show items such as firewalls, fire dampers, and fire alarm devices.

.2 Fire alarm wiring diagrams and schematics, with zone identification and device address list.

2.6 Fire Alarm Control Panels

.1 General:

.1 Control panel circuit for 24V dc, power limited, initiating circuits per NFPA 70, Article 760.

.2 Enclosure:

.1 NEMA 250 Type 1.

.2 Color: Red.

.3 Internally Mounted Module with:

.1 Transformer with 120 V ac input.

.2 Solid state rectifier, fuse protected, filtered, and regulated.

.3 Solid state transfer switch, minimum 8 amp-hours.

.4 Standby batteries sized for system operating period of 24 hours of standby mode operation.

.5 Solid state battery charger.

.6 Over/under voltage monitor supervisory circuit.

.7 LEDs for status of normal power, battery trouble, and power supply module trouble.

.8 Alarm mode of 5 minutes after standby operation.

.4 Local differentiating audible sound device for alarm, trouble, and supervisory conditions.

.5 Full digital transmission protocol.

.6 Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.

.7 Form C output circuitry for remote alarm control panel rated for a minimum of 2.0 amps at 30 Vdc.

.8 MOV/gas discharge transient protection for power supply module, plus initiating and indicating alarm devices.

.9 For addressable systems provide additional 20 percent capacity for future indicating and initiating devices.

.10 EMI/RF Protection:

.1 Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from affects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.

.2 System shall be designed and installed so as to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 300 mm of system components.

.2 Three-Mode Control Panel:

.1 Alarm, supervisory, and trouble modes of operation.

.2 Modular construction with solid state microprocessor-based components and central processing unit, continuously scanning each module for status change.

.3 Operator Interface Panel:

.1 Indicators, control switches, and tone device.

.2 LCD or digital display to indicate event type and zone location or LEDs with differentiating color lenses for:

.1 AC power on.

.2 Power trouble.

.3 System trouble.

.4 Supervisory alarm.

.5 Earth-ground trouble.

.6 Alarm for each zone.

.7 Trouble for each zone.

.8 Alarm signaling circuit trouble.

.9 Annunciator circuit trouble.

.3 Control Switches for:

.1 Alarm silence.

.2 System reset.

.3 Trouble signal silence and ring-back feature.

.4 Municipal connection circuit disconnect.

.5 Manual evacuation drill.

.6 Auxiliary one bypass.

.7 Auxiliary two bypass.

.4 Piezo-electric tone device with pulsed march time rate for alarm and continuous for trouble conditions.

.4 Separate annunciator outputs rated 2-milliamperes supervisory and 120-milliamperes alarm.

.5 Smoke Detector Output:

.1 Two- or four-wire as required, rated 2 amperes, 24V dc.

.2 Interrupted when system is reset.

.6 Supervised remote inputs for alarm silence and system reset.

.7 Switch Selectable:

.1 System diagnostic tests.

.2 Alarm verification.

.3 Alarm silence inhibit.

.4 March time alarm code at cadence of 120 beats per minute.

.5 Temporal alarm code repeated at 1/2-second on and off intervals.

.6 Signal alarm circuit cutout.

.7 Water flow and sprinkler supervisory.

.8 Sprinkler supervisory.

.9 Manual evacuation.

.10 Selective signaling.

.8 Four alarms and one trouble, Form C auxiliary/output relays rated 2 amperes, 30V dc, 0.5 ampere, 120V ac each.

.9 Minimum of 12 input zones.

.3 Addressable Control Panel:

.1 Modular construction with solid state, microprocessor-based components, programmable central processor unit, back lighted display of primary control status and essential alarm operating conditions, and concealed, maintenance, purpose operator's keypad.

.2 Class B Signaling Line Circuits.

.3 Class B, Style Y Notification Appliance Circuits.

.4 Class B, Initiating Device Circuits.

.5 Main control module consisting of operator's keyboard/keypad, local and remote communications and supervision capabilities, system control memory, and programming interface.

.1 Two-line, back lighted, 80 alphanumerical LCD characters with:

.1 Visible cursor for entering data information.

.2 Displayable when cabinet door is open.

.2 Primary operators keypad with:

.1 Acknowledge keys and LEDs for system alarm, supervisory service, and system trouble conditions.

.2 Power on LED.

.3 Alarm silence reset keys.

.4 Displayable when cabinet door is closed.

.3 Pass code protected action display keypad for:

.1 Circuit/device enable or disable.

.2 Control on/off.

.3 Test/status.

.4 Auto or manual.

.5 Activate/reset.

.6 Display historical logs/real time.

.7 Function/menu.

.8 Program.

.9 Delete.

.10 Displayable when cabinet door is open.

.4 Numerical entry and selection keypad, used in conjunction with action display keypad, to perform control function on system zones, initiating circuits, or auxiliary relays, and to gain access to system information. Displayable when cabinet door is closed.

.5 Programmable control keypad with five pass code keys, associated LEDs, and identification labels for:

.1 Elevator bypass.

.2 Manual evacuation.

.3 HVAC shutdown disable.

.4 Displayable when door is open.

.6 Four function keys for control of variable functions related to primary operations keypad, displayable when door is open.

.6 TIA 485, NFPA 72, Style 4, Style 6, or Style 7 data circuit capability for remote annunciators.

.7 Form C relay contacts rated 2 amperes, 24V dc.

.8 Down loader port for connection to microprocessor-based transponder.

.9 Power supply interface module generating digital voltage and current data to LCD with:

.1 dc power conversion and output terminals.

.2 Supervision and control of power supply.

.10 Modules with coded input on first alarm, local trouble LED, and in/out capabilities for:

.1 120 addressable initiating alarm sensors consisting of analog/addressable or traditional detector methods.

.2 Four hardwired I/O points, field selectable in any combination to be either NFPA 72, Style B or Style D, initiating device circuits or NFPA 72, Style Y or Style Z, indicating appliance circuits or auxiliary control circuits.

.3 Auxiliary control circuit contacts shall be single-pole, double-throw, rated 2 amperes at 24V dc and 0.5 amperes at 120V ac.

.11 Auxiliary control circuit contacts shall be single-pole, double-throw rated, 2 amperes at 24V dc and 0.5 ampere at 120V ac.

.12 Two isolated TIA 232 communication port modules.

2.7 Central Processing Control Panel

.1 Modular construction with solid state, microprocessor-based programmable control processor, printer, operator console, and 10 levels of priorities for staging of system events.

.2 Operator Panel:

.1 80-character, 2-line, LCD display.

.2 Individual keys for location information, silence signal, and detector reset.

.3 Lamp test pushbutton with associated LED.

.4 Priority and trouble alarm light-emitting diode and associated acknowledge pushbuttons.

.3 Examine pushbuttons for "Monitor On" and activating control points.

.4 Keyboard consisting of 48 keys labeled with letters, numbers, and options for programming and operational commands.

.5 Printer with thermal print head for 20-column record system events produced in 80-column format.

.6 Input/output ports as required for TIA 232 communication to local UL listed printer.

.7 Selectable alarm verification and distribution processing.

.8 Capable of interfacing with remote panels connected to hardwire circuits with:

.1 Analog/addressable or traditional detectors.

.2 Either normally open or normally closed contacts.

.3 Supervised and 24V dc operated fire alarm signaling circuits.

.4 Capable of interfacing with NFPA 72, hard-wired, Style B and Style D, initiating device circuits and NFPA 72, hard-wired, Style Y and Z, indicating appliance circuits.

.5 Network capability.

2.8 LED Lighted Annunciator

.1 Modular constructed back illuminated, with group mounted LEDs installed in surface mounted cabinet having lockable, full hinged door panel, and red baked enamel finish.

.2 Rectangular LED units extending through black modular insert with multiple red LEDs per module, engraved zone identification nameplate above each lamp, group mounted with quick disconnect harness, and attached to door by concealed fasteners.

.1 Nameplates:

.1 12 mm high by 12 mm wide.

.2 Two lines with 11 maximum, 2.4-mm high engraved letters and spaces per line.

.3 Black plate surface with white engraved letters.

.3 LED test feature with one test switch mounted on cabinet back plate for group test of LEDs on each module.

.4 Remote system reset key switch, trouble assembly consisting of LED, buzzer, and relay and key switch for trouble silence, two-step drill key switches, operating power trouble lamp, and audible tone alarm.

2.9 Serial Annunciators

.1 Modular constructed with 80-character LCD display and remote command modules installed in surface mounted cabinet having lockable, full hinged door panel, and red baked enamel finish.

2.10 Addressable Detector Base

.1 Solid state circuitry with integral LED visual alarm, remote LED output, DIP switch or program selectable addressing, and common base receptacle for ionization, photoelectric, and heat detectors. Device address shall be located in base.

.2 Constantly monitors detector status and status changes.

.3 Suitable for mounting on standard outlet box.

.4 Normally open contacts rated 3 amperes, for resistive loads.

2.11 Individual Addressable Module

.1 Solid state circuitry with selectable latch/nonlatch operating conditions and mounting plate.

.2 Monitors single and multiple devices with dry contacts.

.3 Suitable for installing inside 100 mm by 100 mm by 64 mm electrical box.

2.12 Initiating Device

.1 Pull Station, Fire:

.1 Constructed of die-cast metal with baked red enamel finish, weatherproof housing**,** and raised white letters stating "FIRE."

.2 Finished Areas: Flush-mounted with hinged front cover having keyed or allen-wrench reset lock. Provide surface mounted type in unfinished areas.

.3 Where required, rated for use in hazardous environments.

.4 Recessed pull handle for single action lift door and pull handle for double action operating station with plastic break rod.

.5 Activated station pull handle, latched in protruding position until reset by key.

.6 Stations keyed alike with FACP.

.7 Normally open, contacts rated 3 amperes, for resistive loads.

.8 Manual Pull Station: Microprocessor-based communication circuit, DIP switch selectable address, and compatible with FACP.

.2 Heat Detector:

.1 Combination rate-of-rise and fixed, temperature elements with 57 °C trip setting, complete with addressable mounting base.

.2 Nonrestorable fixed temperature elements self-restoring rate-of-rise temperature elements.

.3 Dangling disk indicator for activated fix temperature element LED indicator for activated rate-of-rise temperature element.

.4 Attach detector bases on surface mounted octagon boxes.

.5 Conceal surface mounted boxes with surface trim skirt.

.6 Double-screw terminals for supervised connection.

.7 Normally open, contacts, rated 3 amperes, for resistive loads.

.3 Smoke Detector:

.1 Ionization or photoelectric type with plug-in, twist-lock addressable base per UL 217 and UL 268.

.2 Solid state circuitry.

.3 Concealed, field adjustable, sensitivity test switch.

.4 LED; pulsed indication for power availability and steady indication for activated detectors.

.5 Self-Compensating Circuitry:

.1 Voltage Range: 15 to 30V dc, 24V dc nominal.

.2 Temperature Range: 0 to 38 °C.

.3 Operating Temperature Range: -10 to 50 °C.

.4 Humidity Range: 0 to 95 percent relative humidity.

.6 Normally open, contacts, rated 3 amperes, for resistive loads.

.7 Detectors equipped with insect screen.

.8 Photoelectric sensors adjusted to within 3 percent of UL 217 window obturation sensitivity value.

.4 Intelligent Fire Detectors:

.1 Photoelectric and thermal detector software programmable from FACP to match specific hazards and reduce nuisance tripping.

.2 Addressable base to be field mounted on octagon box.

.3 Software programmable to provide pre-alarm notification.

.4 Capable of producing alarm from photoelectric detector, thermal detector, or microprocessor logic.

.5 Field cleanable chamber with replaceable chamber components.

.6 LED in base to provide status; Pulsed green for normal status, flashing amber for fault or fail condition, and flashing red for alarm.

.5 Air Duct Smoke Detector:

.1 Duct mounted housing with prealigned sampling and exhaust tubes, analog sensing, solid state circuitry, and plug-in, twist-lock addressable base for photoelectric detector in accordance with UL 286A, NFPA 72, NFPA 90A, and NFPA 101.

.2 Sampling tubes to extend full width of branch air return duct.

.3 Self-Compensating Circuitry:

.1 Voltage Range: 15 to 30V dc, 24V dc nominal.

.2 Temperature Range: 0 to 38 °C.

.3 Humidity Range: 10 to 90% relative humidity.

.4 Velocity Range: 2 to 20 m/s.

.4 Front mounted LED with pulsed indication for alarm condition.

.5 Normally open, single-pole, double-throw auxiliary relay with 2 amperes, rated contacts for resistive loads.

.6 Detector Accessories:

.1 Remote test station and power-on indictor with LED alarm indicator and two-position, key-operated switch for air duct smoke detectors.

.2 Remote LED alarm indicator.

.3 End-of-line device with normally open relay contacts for zone voltage monitoring.

2.13 Alarms

.1 Audible Alarm:

.1 General:

.1 Polarized, 24V dc device with sound power measured dB in accordance with UL 464.

.2 Separate in/out wire leads for field connections.

.3 Baked red enamel finish.

.4 Audibility: In accordance with NFPA 72 and local requirements.

.2 Modular Horn:

.1 Surface basic unit, complete with projector, designed for mounting on 100 mm square standard electrical box.

.2 Manufacturer supplied box with flush grille plate and basic surface unit for recessed horns.

.3 Explosion-Proof Horns: Vibrating diode type with sealed wires, and tapped for 20 mm conduit in accordance with UL 1604.

.3 Modular Bell: Vibrating basic unit complete with 150 mm gong and outdoor yard hood, designed for mounting on 100 mm weatherproof electrical box.

.4 Chime: Vibrating type with field adjustable volume control, designed for mounting on 100 mm square electrical box.

.5 Single protection type bell with weatherproof housing, rated for 120V ac motor, adjustable mounting bracket, and audible output of 115 dB.

.2 Visual Alarm, Fire:

.1 Polarized, 24V dc, multi-candela indicating output per UL 1638.

.2 Solid state circuitry for control of xenon flashtube.

.3 Tamper-proof, translucent molded, polycarbonate, pyramidal shaped lens with "FIRE" in red lettering visible from 180-degree viewing field; red enclosure.

.4 Polarized in/out wiring.

.5 Designed for mounting on wall or ceiling as required, single-gauge electrical box, or as part of audible/visible base housing.

.3 Visual Alarm, Emergency Alarm:

.1 Polarized, 24V dc, 100 candela indicating output per UL 1638.

.2 Solid state circuitry for control of xenon flashtube.

.3 Tamper-proof, translucent blue, molded polycarbonate, pyramidal shaped lens with "EMERGENCY" in lettering visible from 180-degree viewing field; blue enclosure.

.4 Polarized in/out wiring.

.5 Designed for mounting on wall or ceiling as required, single-gauge electrical box, or as part of audible/visible base housing.

.4 Audio Visual Alarm:

.1 Audible/visible base housing with visual alarm and front mounted horn as specified.

.2 Semi-flush mounting on recessed 4-gauge square electrical box or surface mounted on backbox with adapter.

.3 Audibility: In accordance with NFPA 72 and local requirements.

.4 Synchronous audible/visible output.

.5 Bi-Color Warning Lights:

.1 Corrosion-resistant metal fixture with green and red globes.

.2 24V dc, LED lamps; green steady, red flashing.

.3 UL Listed for wet and outdoor installation.

.4 Wall mount design.

2.14 Wiring

.1 AC power wiring shall meet requirements of Section 16125, Wires, Cables and Hardware up to 1000V.

.2 Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

.3 Network or addressable loop cables shall be as recommended by manufacturer for installation of their system and UL Listed for Fire Alarm Systems.

2.15 Raceways

.1 Conduit used for installation of Fire Alarm system shall follow requirements as identified in Section 16111, Conduit, Conduit Fastenings and Conduit Fittings.

.2 Coordinate with Div. 16.

2.16 End-of-Line Resistors

.1 Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.

2.17 Surge Suppressors

.1 Transient Voltage Surge Suppressors (TVSS):

.1 Provide to suppress voltage transients that might damage fire alarm panel/transmitter components. Unit shall wire in series to power supply of protected equipment with screw terminations.

.2 Unit shall be UL 1449 listed with a 330-volt suppression level and have a maximum response time of 5 nanoseconds.

.3 Unit shall meet IEEE C62.41 Category B tests for surge capacity.

.4 Features:

.1 Multi-stage construction that includes inductors and silicon avalanche zener diodes.

.2 Long life indicator lamp (LED or neon lamp) which extinguishes upon failure of protection components. Fusing shall be externally accessible when this feature is available.

.5 Manufacturer and Product: Edco of Florida, Ocala, FL; Model HSP-121BT2.

3. EXECUTION

3.1 General

.1 Coordinate with other trades for mounting and interfacing with fire alarm system related devices.

.2 Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein and for interconnection of flow and supervisory switches and alarm bells specified in Section 13930, Fire Suppression System, and shunt tripping of elevator power for complete and operable system.

3.2 Installation

.1 Install and connect fire detection and alarm equipment in accordance with manufacturer's instructions and recommendations, and in accordance with applicable codes and standards.

.2 Mount devices in accordance with manufacturer's instructions.

.3 Provide outlet and junction boxes that are compatible with raceway system.

.4 Mount detector LEDs so they are readily visible from floor.

.5 Arrange sampling tubes and duct detectors to monitor duct area and point of duct penetration sealed and reinsulated.

.6 Install conductors in accordance with Section 16125, Wires, Cables and Hardware up to 1000V.

.7 Install initiating alarm, signal, and communication conductors in separate and independent raceway system.

.8 Circuit wiring color-code, as established by Contractor, to be maintained throughout installation.

.9 Size conductors in accordance with device manufacturer's recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.

.10 Detectors shall not be installed until after construction clean up of trades is complete, per requirements of NFPA. Exception, where required by AHJ for protection during construction, detectors installed prior to final clean-up by trades shall be cleaned or replaced.

.11 Duct Smoke Detector: Furnish, wire, and connect to fire alarm system in accordance with this Specification. Installed in accordance with Section 15901, HVAC Controls, Field Components, and Instruments.

.12 HVAC Equipment: Wire and connect fire alarm system to air handling system, smoke exhaust fan and smoke damper control circuits, and fan status contacts. Coordinate work with Section 15900, HVAC Instrumentation and Controls-General.

.13 Suppression Sprinkler System: Wire and connect to fire alarm system to suppression sprinkler system. Coordinate work with Section 13930, Fire Suppression Sprinkler System.

.14 Wire and connect fire alarm system to elevator communications circuit and alarm.

3.3 Conduit

.1 Conduit for the fire alarm system will be supplied and installed by Division 16.

.2 Requirements apply to fire alarm system conduits, electrical enclosures, terminal cabinets, junction boxes, pullboxes, and device backboxes.

.3 Conduit systems shall be dedicated to fire alarm system and shall contain no unrelated conductors.

.4 Fire alarm system conduits shall be of sizes and types specified under Section 16111, Conduits, Conduit Fastenings and Conduit Fittings.

.1 Conduit shall be as identified under Section 16111, Conduits, Conduit Fastenings and Conduit Fittings. Flexible metallic conduit may be used for whips to devices only, maximum length 1.8 m, 20 mm diameter minimum. Set screw type couplings or connectors are specifically prohibited.

.2 Size conduits according to conductors contained therein. Cross sectional area percentage fill for fire alarm system conduits shall not exceed 40 percent.

.5 Route and install conduit to minimize potential for physical damage, either mechanical or by fire, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance. Coordinate installation between different trades to avoid conflicts.

.1 Conduit, except flexible conduit whips to devices, shall be solidly attached to building structural members or permanent walls. Conduit shall not be attached to existing conduit, ductwork, cable trays, other ceiling equipment, drop ceiling hangers/grids or

partition walls, except where necessary to connect to initiating, evacuation signaling or auxiliary function devices.

.2 Conduit shall be routed either parallel or perpendicular to building structural members.

.3 Conduit shall be installed at a height so as not to obstruct any portion of a window, doorway cable tray, stairway or a passageway, and shall not interfere with operation of existing mechanical or electrical equipment.

.4 Conduit, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device backboxes shall be readily accessible for inspection, testing, service and maintenance.

.5 Conduits shall be arranged to minimize the possibility of water in those conduits draining through control panels.

.1 Conduit, except nipples between control panels shall be arranged to enter control cabinets from below.

.2 Conduit shall be provided with three, 6 mm drain holes at horizontal low point beneath each control cabinet.

.6 Bushings shall be provided at termination of conduit, prior to installation of wire.

.7 Install junction boxes as necessary. Conductors shall be pulled through junction boxes, without splices.

.8 Pullboxes shall be installed in each conduit at intervals not to exceed 100 feet. Pullboxes shall be 100 mm square, minimum.

.9 Device backboxes and junction boxes shall be sized to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.

.10 Junction boxes, pull boxes, terminal cabinets, device backboxes, and raceways shall be gasketed and weather-tight per requirements of Section 16111, Conduits, Conduit Fastenings and Conduit Fittings.

.6 Conduit, junction boxes, panels, electrical enclosures, relays and device backboxes shall be exposed in unfinished areas. Conduit and device backboxes shall be concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on Drawings. Exposed conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

.7 Conduit penetrations of walls, floors and ceilings will be sealed around conduit(s), by other, restoring walls, floors and ceilings to their original condition, fire resistance and integrity.

.8 Pull boxes, junction boxes, conduit bodies, and terminal cabinets shall be painted "fire engine red" prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.

.9 Conduit shall be grounded by approved ground clamps.

.10 Mount end-of-line resistors on terminal blocks.

.11 Detection and alarm wire shall be installed in separate conduits. Outgoing and return conductors for each supervised circuit shall be routed in separately as required by NFPA 72. The minimum separation of outgoing and return conduits shall be 300 mm vertically and 1.2 m horizontally.

3.4 Identification

.1 Junction, terminal, and pulling box covers shall be painted red and identified with engraved labels by loop number and circuit that it contains.

.2 Detection and terminal devices shall have engraved alphanumeric identification that shall be keyed to posted operations and maintenance instructions.

3.5 Conductors

.1 Requirements apply to fire alarm system conductors, including all signaling line, initiating device, indicating appliance, releasing function, remote signaling, ac and dc power and grounding/shield drain circuits.

.2 Conductors shall be:

.1 New. Wire that has scrapes, nicks, gouges or crushed insulation shall not be used.

.2 Installed in conduit.

.3 Continuous between devices and between devices and intermediary terminal cabinets.

.4 Low voltage conductors shall be minimum size No. 14 AWG. Smaller conductors shall only be permitted where part of a manufacturer's specific communications cable, i.e. addressable system.

.3 Splices in conductors are specifically prohibited.

.4 Types:

.1 Conductors, except ac power conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper.

.2 Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.

.5 Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.

.1 Terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.

.2 Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.

.3 Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on Contractor's Record Drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.

.4 Wire nuts are prohibited.

.5 Where pigtail devices are factory provided with wires too short to be connected to terminal strips (i.e., solenoids), such connections shall be soldered and taped.

.6 Control Panel Wiring:

.1 Fully dressed and bundled with nylon tie wraps at 75 mm intervals.

.2 Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections.

.3 AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 50 mm separation shall be maintained between ac power conductors and low voltage conductors wherever possible.

.4 Control cabinets shall be sized to accommodate the requirements of this Section.

.5 Control panels shall not be used as raceways. Conductors that do not terminate within a control panel shall not be routed through that control panel.

.7 Conductors shall be separated into the following categories:

.1 Low voltage circuits that serve devices.

.2 ac power circuits.

.8 Each category of conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another, except at common associated control equipment. Conductors shall be further segregated as necessary to conform to fire alarm system manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

.9 Wiring shall be THHN or TFFN stranded. Use of multi-conductor twisted pair or similar wiring is not permitted.

.10 Install as nonpower limited circuits in accordance with NFPA 72.

.11 Conductors looped around terminals are prohibited.

.12 Wire nut splices are prohibited.

.13 T-tapping of circuits is prohibited.

.14 Circuits shall be megger tested to voltage rating of their insulation before final terminations are made.

3.6 Overvoltage and Surge Protection

.1 Install TVSS for FACP per manufacturer's requirements.

3.7 Repair/Restoration

.1 Touch up scratches, mars, and dents, incurred during shipment or installation of equipment.

.2 If required because of extensive damage, as determined by Contract Administrator, refinish entire assembly.

.3 Keep covers on smoke detectors until areas have been thoroughly cleaned.

3.8 Tests and Inspection

.1 In accordance with ULC-S537 and NFPA 72.

.2 Demonstrate entire system meets performance requirements specified in Article System Description.

.3 Perform tests in presence of code-enforcement authorities and Contract Administrator

.4 Each smoke detector shall be individually field tested prior to installing device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating system address, type of device, sensitivity and initials of technician performing test, using test equipment specifically designed for that purpose, shall be prepared and kept for final acceptance documentation. After testing detection devices, base shall be labeled

with system address, date, and initials of installing technician. Labeling shall not be visible after installation is complete.

.5 Test wiring runs for continuity, short circuits, and grounds before system is energized. Resistance, current, and voltage readings shall be made as work progresses.

.1 Systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on logging form for readings, dates, and witnesses.

.2 Notify AHJ and Contract Administrator before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.

.3 Deliver test reports to AHJ and Contract Administrator as completed.

.6 Prepare as-built Sequence of Operations Matrix referencing each alarm input to every output function affected as a result of an alarm, trouble, or supervisory condition on that. In case of outputs programmed using more complex logic functions involving “any”, “or”, “not”, “count”, “time”, and “timer” statements; complete output equation shall be referenced in matrix.

.7 Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.

.1 Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:

.1 Open, shorted, and grounded intelligent analog signaling line circuit.

.2 Open, shorted, and grounded network signaling line circuit.

.3 Open, shorted, and grounded conventional initiating device circuits.

.4 Primary power or battery disconnected.

.5 Intelligent device removal.

.6 Incorrect device address.

.7 Loss of data communications between system control panels.

.8 Loss of data communications between system annunciators.

.2 Demonstrate system evacuation alarm indicating appliances as follows:

.1 Alarm notification appliances actuate as programmed.

.2 Audibility and visibility at required levels.

.3 System indications shall be demonstrated as follows:

.1 Correct message display for each alarm input, at control panel, each remote alphanumeric LCD display.

.2 Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.

.4 Demonstrate system onsite and offsite reporting functions as follows:

.1 Correct alarm custom message display, address, device type, date and time transmitted, for each alarm input.

.2 Correct trouble custom message display, address, device type, date and time transmitted, for each alarm input.

.3 Trouble signals received for disconnect.

.5 Secondary power capabilities shall be demonstrated as follows:

.1 Disconnect system primary power for a period of time as specified herein; at end of period, alarm condition shall be created and system shall perform as specified for period as specified.

.2 Restore system primary power for 48 hours and system-charging current shall be normal trickle charge for fully charged battery bank.

.3 Check system battery voltages and charging currents at FACP using test codes and LCD displays

.8 In the event system fails to perform as specified and programmed during acceptance test, test shall be terminated at discretion of acceptance inspector.

.1 Retest system, correcting deficiencies and providing test documentation to acceptance inspector.

.2 In event that software changes are required during acceptance test, system manufacturer to compare edited program with original and shall furnish utility program. Utility shall yield printed list of changes and system functions, inputs and outputs affected by changes. Items listed by program shall be minimum acceptable to be retested before calling for resumption of acceptance test. Submit printed list and printer log of retesting before scheduling of acceptance test.

.3 Acceptance inspector may elect to require complete acceptance test to be performed again if, in their opinion, modifications to system hardware or software warrant complete retesting.

.9 Upon completion of tests, complete and provide the following:

.1 NFPA 72, Record of Completion, and Inspection and Testing Form.

.2 Certification that final system meets ULC.

3.9 Manufacturer's Services

.1 Furnish manufacturer's representative in accordance with Section 01664, Training, **f**or the following services at Site or classroom as designated by Contract Administrator, for minimum person-days listed below, travel time excluded:

.1 3 person-days for installation assistance and inspection.

.2 3 person-days for functional and performance testing.

.3 2 person-days for prestartup classroom or Site training.

END OF SECTION

FIRE SUPPRESSION SYSTEM

1. GENERAL

1.1 Scope of Work

.1 The Section covers the requirements for a wet-pipe portable extinguishers, standpipe system and fire pumps for the Main Water Treatment Building.

.2 This Section covers the supply and installation of fire hose cabinets and portable fire extinguishers.

1.2 References

.1 The following is a list of standards which may be referenced in this section:

.1 National Fire Protection Association (NFPA):

.1 10, Standard for Portable Fire Extinguishers.

.2 13, Standard for the Installation of Sprinkler Systems.

.3 14, Standard for the Installation of Standpipe Systems.

.4 20, Standard for the Installation of Stationary Pumps for Fire Protection.

1.3 Design Requirements

.1 General:

.1 Design the fire suppression sprinkler system in accordance with the requirements of this section.

.2 Coordinate the design of the fire suppression sprinkler system with the authorities having jurisdiction in the Project locality. Obtain required permits and arrange for inspections required by such permit.

.3 Coordinate fire suppression sprinkler system routing with building structure, other piping, ductwork, and electrical.

.4 The fire pumps and jockey pumps are shown on schematic drawing WH-P0008. The intent is to show the overall concept for the pumps. Provide all piping, accessories, instruments and appurtenances required to meet the referenced NFPA standards.

.5 Verify and incorporate into the design the actual water pressure and available water flow for the fire suppression sprinkler system.

.6 Locate sprinkler heads in ceiling tile in a generally symmetrical configuration.

.7 Design fire suppression system to interface with Section 13850, Fire Detection and Alarm.

.2 Automatic Wet Pipe System:

.1 Provide an automatic wet pipe system for the water treatment plant building covering the areas as shown on the drawings including Administration Area, Chemical System Area, Mechanical Rooms No. 1, 2, 3 and 4, and Blower/Compressor Room. Refer also to the Drawings for areas requiring sprinkler coverage.

.2 Floor control valve assemblies at each floor level and for each riser. Supervise floor control valves to alarm on closure. Pipe floor control valve drains to building drainage system.

.3 Design for the following areas:

Area No.	Description	Building Level	Sprinkler Coverage Area (m^2)	Notes
1	Administration-Lobby, Vestibule No.1, Stairwell No.1	Main	54	1
2	Maintenance Workshop (Rm 111) Polymer Preparation & Feed Room (Rm 112) Peroxide Storage & Feed Room (Rm 113) Dry Polymer Storage Room (Rm 114) Receiving (Rm 115) SBS Storage & Feed Room (Rm 116) Garbage Recycling (Rm 117) Storage Room (Rm 118) Mech/Elec Storage (Rm 119) Welding Area Electric Shop	Main	1280	2
3	Administration Area – Second Level	Second	557	1
4	Mechanical Room No. 1	Third	125	2
5A	Polymer Preparation Platform	Second	95	2
5B	Instrumentation Repair Shop, Coffee Room, Office, Storage, O&M Manual Room, Washroom, Vestibule No.3	Second	205	2
5C	Storage	Second	58	2
6	Administration Area – Third Level	Third	827	1
7	Mechanical Room No. 2	Third	1460	2
8	Blower & Compressor Room	Third	160	2
9	Mechanical Room No. 3	Third	470	2
10	Mechanical Room No. 4	Third	220	2

Notes:
1. Hazard Occupancy: Light. Hydraulic Operation Area: 278 m^2 (3,000 ft^2) at an area/density rating of 2.9 L/min/m^2 (0.07 gpm/ft^2).

Area No.	Description	Building Level	Sprinkler Coverage Area (m^2)	Notes
2.	Hazard Occupancy: Ordinary, Group 1. Hydraulic Operation Area: 372 m^2 (4,000 ft^2) at an area/density rating of 4.1 L/min/m^2 (0.10 gpm/ft^2).			

.3 Wet Standpipe System:

.1 Provide wet standpipes in exit stairwells at the locations shown on the Drawings.

.2 Suitable for Class II service per NFPA 14.

.3 Provide hose connections in the exit stairwells in accordance with NFPA 14. Provide hose connections to serve each floor of 65 mm size, even though they are not specifically required for Class II service. Provide hose connections to serve each floor and at roof where stairwell provides roof access.

.4 Provide hose stations for 40 mm hose in accordance with the National Building Code and NFPA 14. Provide fire hose cabinets at hose station locations.

1.4 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Reflected ceiling plans showing sprinkler head locations.

.2 Plan drawings showing location of all piping, valves, hose cabinets, hose connections, control valves, control devices and appurtenances.

.3 Schematic, wiring, and interconnection diagrams of system.

.4 Catalog cuts of system components.

.5 Design calculations.

.6 Pumps

.1 General layout and complete piping diagram.

.2 Characteristics curves.

.3 Cross section details and complete materials list.

.4 Motor and wiring details.

.2 Informational Submittals:

.1 Written documentation showing proof of system designer's and Contractor's qualifications.

.2 Manufacturer's installation instructions for supervisory switches.

.3 Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation. Complete Certificate of Satisfactory Installation, Form 102.

.4 Written evidence that required permits have been secured and that inspections and acceptance tests have been satisfactorily performed.

.5 Written test reports of each test and inspection.

.6 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

1.5 Quality Assurance

.1 Qualifications: Design and installation shall be performed by persons with an established reputation in the fire protection industry who can furnish a list of satisfactory installations of the type of system specified. Design shall be performed by a Professional Engineer registered in the Province of Manitoba. Seal, sign and date all drawings and hydraulic calculations.

.2 Regulatory Requirements:

.1 National and Provincial Fire Codes.

.2 National and Provincial Building Codes.

.3 Authorities having jurisdiction.

1.6 Spare Parts

.1 Furnish, tag, and box for shipment and storage, spare parts in accordance with NFPA 13, including:

.1 Sprinkler heads.

.2 Detection devices and fusible elements.

2. PRODUCTS

2.1 General

.1 Materials manufactured within scope of Underwriters Laboratories shall conform to UL Standards and have an applied UL listing mark.

.2 All equipment shall be Factory Mutual (FM) approved.

2.2 Fire Pump Package

.1 Provide and install a complete fire pump Vendor Package in accordance with the requirements of NFPA 20. The fire pump shall be listed by Underwriter's Laboratory of Canada for fire pump service at the specified rating. All equipment shall be ULC listed and FM approved.

.2 Fire pump package to include:

.1 Fire pump with electric motor, tag number P-H110A.

.2 Emergency pump with electric motor

.3 Two vertical multi-stage jockey pumps with electric motors and automatic controllers. Controllers shall be completely assembled, wired, and factory tested.

.4 Control panel.

.5 Automatic transfer switch.

.6 Accessories.

.3 Fire Pump General:

.1 Pumps shall be horizontal-split-case type design with double suction, cast iron pump casing, bronze or ductile iron impeller.

.2 The fire pump shall be direct connected through a flexible coupling to a horizontal electric motor with a 1.15 service factor.

.4 Fire Pump Motor Controller:

.1 CSA Approved and labelled.

.2 Provide an electric motor controller, microprocessor-based, factory assembled and wired with an automatic power transfer switch listed by ULC for use with generator emergency power source. The controller shall be mounted in a NEMA/EEMAC 2 enclosure, wall mounted, complete with drip shield suitable for pump room environment.

.3 Soft-start or across-the-line motor starters as indicated in the schedule below.

.4 Minimum run timer.

.5 Automatic transfer switch shall be capable of automatic power transfer from normal to alternate power source in case of voltage drop, phase failure, or phase reversal. Switch shall be capable of automatic re-transfer after restoration of normal power.

.6 Automatic transfer switch with full service pump controller shall be mounted in separate enclosures, mechanically attached to form one unit and include protected interlock wiring.

.7 Acceptable Manufacturers

.1 Tornatech.

.2 Hubbell.

.5 Jockey Pump:

.1 Provide and install vertical multi-stage centrifugal jockey pump, tag number P-H120A.

.6 Jockey Pump Controllers:

.1 Provide a jockey pump controller for each jockey pump.

.2 CSA Approved and labelled.

.3 Control transformer, power indicating light, pump run indicating light.

.7 Accessories:

.1 Flow meter

.2 Steel baseplates

.3 Casing relief valves

.4 Automatic air release valves.

.5 Compound suction and discharge pressure gauges, with 89mm dials.

.6 Interconnecting piping.

.7 Suction and discharge valves, check valves, discharge header.

.8 Pump shaft couplings and guards.

.9 ULC Listed OS&Y isolating gate suction valves

.10 ULC Listed isolating butterfly discharge valves with tamper switches.

.11 ULC Listed wafer check valve.

.12 Test header.

.13 Other valves and fittings as required and as shown on the drawings.

.8 All components of the fire pump package shall be supplied by the manufacturer as a complete package shop-assembled to greatest degree practicable.

.9 Provide all items not specifically called out which are required to implement the specified functions and the functions required for proper system operation.

.10 Factory test equipment in accordance with NFPA, ULC, UL and FM prior to shipment.

.11 Paint equipment with manufacturer's standard machine enamel.

.12 Acceptable Manufacturers:

.1 ITT Industries.

.2 Armstrong.

2.3 Emergency Pump Package (tag numbers P-H130A, P-H140A)

.1 Provide and install a complete emergency pump Vendor Package in accordance with the requirements listed above for Fire Pump Package, with the following exceptions:

.1 The pumps and controller do not have to be labeled in accordance with NFPA 20.

.2 Pump Performance:

Tag Number	**P-H110A**	**P-H130A**
Pump Name	Fire Pump	Emergency Pump
Capacity (m^3/h)	283 m^3/h (1250gpm)	454 m^3/h (2000gpm)
Discharge Pressure	1035 kPa (150 psig)	520 kPa (75 psig)
Suction Pressure	0 – 50 kPa(g)	0 – 50 kPa(g)
Total Dynamic Head	106 m	53 m

Pumped Fluid	Raw water (0 to 25 ^{o}C)	Raw water (0 to 25 ^{o} C)
Pump Suction and Discharge Connections	ANSI 150-lb flanges	ANSI 150-lb flanges
Driver Type	Electric motor	Electric motor
Motor	150 kW	75 kW
Power Supply	575V/3ph/60 Hz	575V/3ph/60 Hz
Motor Speed	3550 rpm	1750 rpm
Motor Starter Type	Soft start	Across-the-line
Motor Enclosure	TEFC	TEFC
Manufacturer	ITT Fire Pumps	ITT Fire Pumps
Model	8x6x12FM	10x8x17F-S
NFPA 20 Labeling	Required	Not Required

Notes:

.1 Confirm pump head and power requirements based on hydraulic design of sprinkler piping.

.3 Jockey Pump Performance:

Tag Number	P-H120A	P-H140A
Pump Name	Jockey Pump No. 1	Jockey Pump No. 2
Capacity (m^3/h)	19 L/min (5gpm)	19 L/min (5gpm)
Pumped Fluid	Raw water (0 to 25 ^{o}C)	Raw water (0 to 25 ^{o}C)
Driver Type	Electric motor	Electric motor
Motor	0.56 kW	0.37 kW
Power Supply	575V/3ph/60 Hz	575V/3ph/60 Hz
Motor Enclosure	TEFC	TEFC

Manufacturer	ITT Fire Pumps	ITT Fire Pumps
Model	7GBC	7GBC

2.4 Piping

.1 Black Steel: As specified in Section 15200-03, Data Sheet - Carbon Steel Pipe and Fittings-General Service.

2.5 Valves

.1 Indicating type, with supervisory switches. Supervision shall be in the OPEN position such that closing of valves results in alarm.

.2 Gate Valves:

.1 Gate valve, UL/ULC listed, FMRC Approved, flanged iron body, outside screw and yoke, bolted bonnet, solid bronze wedge, bronze seat ring, brass stem, cast iron handwheel, suitable for supervisory switch, 1200 kPa CWP or as required, Nibco model F-607-OTS, Crane, Stockham or approved equal.

.3 Butterfly Valves:

.1 Butterfly valve, UL/ULC listed, FMRC Approved, wafer or lug style body, ductile iron body and disc, stainless steel stem, EPDM seat, gear operator, supervisory switchbox, position indicator, 1720 kPa CWP or as required, Nibco WD3510-8, LD-3510-8, Tyco or approved equal. Provide extension stems and handwheel floor stands where shown on the Drawings.

.4 Check Valves:

.1 Wafer type check valve, UL/ULC listed, FMRC Approved, iron body, bronze disc, double door type, stainless steel spring, bearing and hardware, Buna N seat, 1750 kPa CWP or as required, Nibco model KW-900-W, Check-Rite, Stockham, or approved equal.

.2 Swing type check valve, UL/ULC listed, FMRC Approved, flanged iron body, bolted bonnet, renewable disc and seat, 1200 kPa CWP or as required, drilled and tapped for ball drip outlet, Nibco model F-908-W, Crane, Stockham or approved equal. Provide ball drip valve on bottom of fire department connection check valve

.5 Hose Valves:

.1 Angle globe type, cast brass, handwheel, 65 mm size, with cap and chain.

.2 Suitable for wet standpipe.

.3 Where system pressure exceeds 690 kPa at hose valve outlet, an adjustable hose valve or device is required to reduce pressure, with required flow, at outlet to 690 kPa.

2.6 Supervisory Switch

.1 Suitable for either OS&Y gate valve, butterfly valve or indicator post, as required.

.2 Capable of operating between first and second revolution of valve control wheel or if housing cover is removed.

.3 Rating: 5 amps, 120V ac and 2.5-amp, 24V dc.

.4 Manufacturers:

.1 Potter.

.2 Chemetron.

2.7 Flow Detector Switch

.1 Switch shall actuate on flow of water that equals or exceeds the discharge from one sprinkler head.

.2 Minimum Rating: 5-amp, 120V ac and 2.5-amp, 24V dc.

.3 Pneumatic retard element with an adjustable range of zero to 70 seconds.

.4 Two contacts (DPDT) suitable for providing a signal to the local fire alarm bell and light, and remote fire alarm system.

.5 Acceptable Manufacturers:

.1 Notifier.

.2 Viking.

2.8 Fire Alarm Bell and Light

.1 Suitable for hearing impaired.

.2 250 mm outdoor type, surface mounted with weatherproof back box, 120V, single-phase.

.3 Light:

.1 Revolving 360 degrees, red colored.

.2 Unit shall have a simple technique for replacing lamps.

.4 Housing fabricated of aluminum with red baked enamel finish.

.5 Acceptable Manufacturers:

.1 Notifier.

.2 Simplex.

.3 Federal Sign and Signal Co.

2.9 Fire Department Connection

.1 Wall mounting type, cast brass body with drop clappers, back inlet, 100 mm by 65 mm by 65 mm size.

.2 Unit Finish: Chrome-plated and caps with chains. Engrave "AUTOMATIC SPRINKLER and WET STANDPIPE" on finish plate.

.3 Acceptable Manufacturers:

.1 Potter-Roemer; 5020 Series.

.2 Powhatan; Brass 22-229.

.3 Elkhart; Model 163.

2.10 Fire Hose Cabinet

.1 Cabinet with glass door, hose rack assembly, and fire extinguisher. Provide surface mounted type, except where noted on the Drawings provide semi-recessed type.

.2 Cabinet:

.1 Steel, 0.95 mm (20 gauge), with baked enamel finish.

.2 Cabinet colour: white in Administration Area, red in all other areas.

.3 Door: Steel, 0.95 mm (20 gauge), with 1.2 mm (18 gauge) frame. Finish in gray baked-on primer.

.4 Acceptable Manufacturers:

.1 Semi-Recessed:

.1 Potter-Roemer; Figure 1334.

.2 Sierra Fire Equipment; No. 5402.

.2 Surface Mounted:

.1 Potter-Roemer; Figure 1354.

.2 Sierra Fire Equipment; No. 5408.

.3 Hose Rack Assembly:

.1 40 mm angle valve, hose rack, hose rack nipple, pin lug coupling, 30 linear metres of lined 40 mm hose, and fog nozzle.

.2 Manufacturer and Product:

.1 Potter-Roemer; Figure 2510.

.2 Sierra Fire Equipment; No. 1500J.

.4 Fire Extinguisher:

.1 4.5 kg, Type ABC.

.2 Manufacturer and Product:

.1 Potter-Roemer; Figure 3010.

.2 Sierra Fire Equipment; No. SP10-ABC.

2.11 Sprinkler Head

.1 Temperature Rating: 74°C.

.2 Acceptable Manufacturers:

.1 Viking Corp.

.2 Central Sprinkler Corp.

2.12 Pipe Hangers and Supports

.1 In accordance with NFPA 13 and NFPA 14.

2.13 Valve Identification Tags

.1 In accordance with NFPA 13 and NFPA 14.

2.14 Portable Fire Extinguishers

.1 General:

.1 Conform to NFPA 10 for fire extinguishers.

.2 Furnish fire extinguishers and cabinets from one manufacturer.

.3 All Extinguishers: UL listed, charged and ready for service.

.2 Multipurpose Hand Extinguisher (F. Ext-1):

.1 Tri-class dry chemical extinguishing agent.

.2 Pressurized, red enameled steel shell cylinder.

.3 Activated by top squeeze handle.

.4 Agent propelled through hose or opening at top of unit.

.5 For use on A, B, and C class fires.

.6 Minimum UL Rating: 4A-60B:C, 4.5 kg capacity.

.7 Quantity Required: Provide and install where shown on Drawings plus 3 spares.

.3 Carbon Dioxide Hand Extinguisher (F. Ext-2):

.1 Carbon dioxide.

.2 Pressurized, red enameled steel shell cylinder.

.3 Activated by top squeeze handle.

.4 Agent propelled through hose and spreader nozzle.

.5 For use on B and C class fires.

.6 Minimum UL Rating: 10B:C, 6.8 kg capacity.

.7 Quantity Required: Provide and install where shown on Drawings plus 3 spares.

3. EXECUTION

3.1 Installation - General

.1 Install system in accordance with NFPA 13, NFPA 14 and NFPA 20.

.2 Run drainage piping to nearest hub drain, floor drain or gutter drain.

.3 Grout bases of Fire Pump and Emergency Pump to foundation.

3.2 Valves

.1 Control Valves: Where more than one control valve is required, provide identification signs indicating portion of the total system controlled by respective valve, on valve, or on wall near valve location as specified in accordance with NFPA 13.

.2 System Test and Drain Valves:

.1 Where valves are located above ceilings with removable panels, install panels with a nametag that allows readily visible identifying test valve location.

.2 Where valves are installed above fixed ceilings, install an access panel, and paint to match ceiling color with identification tag for valve.

.3 Install drain valves in portions of system that cannot drain by gravity to main drain valve.

.3 Double Check Valve Assembly: Install with test cocks and nameplate accessible from front of unit.

3.3 Supervisory Switch

.1 Provide on each fire protection system control valve.

.2 Install in accordance with manufacturer's instructions.

.3 Make electrical connections specified in Section 13850, Fire Detection and Alarm.

3.4 Sprinkler Head

.1 Provide chrome-plated canopy flanges on pendant sprinkler heads in finished ceilings.

.2 Provide brass pendant or upright heads in unfinished areas.

.3 Provide guards on sprinkler heads located in areas where heads are subjected to mechanical damage.

.4 Spare Heads:

.1 Provide in accordance with NFPA 13, mounted in manufacturer's standard metal cabinet.

.2 Mount cabinet on wall near fire protection header.

3.5 Flow Detector Switch

.1 Do not mount switch in a pipe fitting or within 300 mm of fittings that change direction of water flow.

.2 Electrical connection as specified in Section 13850, Fire Detection and Alarm.

3.6 Fire Alarm Bell and Light

.1 Mount on building exterior directly above fire department connection.

.2 Electrical connection as specified in Section 13850, Fire Detection and Alarm.

3.7 Pipe Hangers and Supports

.1 Spacing, location, and installation in accordance with NFPA 13.

3.8 Field Finishing

.1 As specified in Section 09901, Painting and Finishing – Process Mechanical.

3.9 Field Quality Control

.1 Upon completion of fire protection system, perform acceptance test as required and outlined in standards NFPA 13, NFPA 14 and NFPA 20.

.2 Notify the authority having jurisdiction of acceptance test readiness.

.3 Provide documentation required by NFPA 13, NFPA 14 and NFPA 20.

3.10 Portable Fire Extinguishers and Cabinets

.1 Provide at locations shown. Review final locations with Contract Administrator before installing, adjusting as required to clear obstructions. Install spares at locations or as directed by Contract Administrator.

.2 Mount hangers securely in position, following manufacturer's recommendations.

.3 Top of Extinguisher: No more than 1.37 m above floor.

3.11 Performance Test

.1 Test in accordance with NFPA 13, NFPA 14 and NFPA 20.

.2 Perform under actual or approved simulated operating conditions.

.3 Test for a continuous 3-hour period without malfunction.

.4 Perform with the Contract Administrator and authority having jurisdiction present.

3.12 Manufacturer's Services

.1 Installation, Testing, and Start-up: Manufacturer's Representative shall provide the following on-site services for minimum person-days listed below, travel time excluded:

.1 One person-two days for installation assistance and inspection.

.2 One person-two days for testing and completion of Certificate of Satisfactory Installation, Form 102.

.3 One person-two days for facility start-up.

.2 Prestart-up Classroom or Site Training: Manufacturer's Representative shall provide the following training at Site or classroom designated by City, travel time excluded:

.1 2-hour training session for training City's operations personnel.

.2 2-hour training session for training City's maintenance personnel.

.3 Training shall be consistent with Section 01664 Training.

.3 Post-start-up Training: Manufacturer's Representative shall provide one person-days at Site or classroom designated by City, travel time excluded.

END OF SECTION

HOIST AND MONORAIL SYSTEMS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American National Standards Institute (ANSI):

.1 B30.10, Hooks.

.2 B30.11, Monorails and Underhung Cranes.

.3 HST 1M, Performance Standard for Electric Chain Hoists

.4 HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.

.5 HST 4M, Performance Standard for Overhead Electric Wire Rope Hoists.

.6 MH27.1, Underhung Cranes and Monorail Systems.

.2 Canadian Standards Association:

.1 CSA C22.1, Canadian Electrical Code, Part I (20th Edition).

.2 CSA C22.2 No. 33-M1984 (R2004), Construction and Test of Electric Cranes and Hoists.

.3 National Electrical Manufacturer's Association (NEMA):

.1 MG 1, Motors and Generators.

.2 250, Enclosures for Electrical Equipment (1,000 volts maximum).

.4 Electrical Equipment Manufacturers Advisory Council (EEMAC):

.1 M1-7, Motors and Generators.

.5 National Fire Protection Association (NFPA): 2005 National Electrical Code (NEC) (NFPA 70):

.1 Article 610, Cranes and Hoists.

.6 Province of Manitoba Occupational Health and Safety Regulations.

1.2 Design Requirements

.1 Monorail System: Specifications for Underhung Cranes and Monorail Systems, ANSI MH27.1 and ANSI B30.11.

.2 Hoist: ANSI B30.11, Hoist Manufacturers' Institute.

.3 Trolley: ANSI MH27.1.

.4 Wire Rope Hoist Service Class: ANSI HST 4M.

.5 Chain Hoist Service Class: ANSI HST 1M.

.6 Hook: ANSI 30.10.

.7 Stress and Safety Factors: ANSI MH27.1 and ANSI B30.11. Properly select materials of construction for stresses to which subjected.

.8 Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ANSI B30.11 and OSHA requirements.

1.3 Submittals

.1 Shop Drawings:

.1 Make, model, weight, and horsepower of each equipment assembly.

.2 Complete catalog information, descriptive literature, materials of construction, and specifications on hoist, wheels, gears and bearing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.

.3 Runway rail.

.4 Power and control wiring diagrams, including terminals and numbers.

.5 Motor nameplate data in accordance with EEMAC M1-7, and include any motor modifications.

.6 Factory finish system.

.2 Information Submittals:

.1 Factory Functional Test Report.

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Field load tests results

.6 Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.7 List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.8 Operation and Maintenance Manual.

1.4 Environmental Requirements

.1 Temperature: Maximum 40 degrees C; minimum 5 degrees C.

.2 Humidity: Maximum 100 percent.

1.5 Spare Parts

.1 Furnish for each remote control crane:

.1 One transmitter.

.2 One battery.

2. PRODUCTS

2.1 General

.1 All equipment in Section 14620 – Hoist and Monorail Systems, and Section 14630 – Overhead Traveling Cranes, are to be supplied by one Manufacturer.

.2 Hoist and trolley Manufacturer to coordinate equipment requirements with steel structures, drive motor, hoisting cable or chain, hook, rails, stops, and electrical equipment controls.

.3 Where adjustable speed drives or remote control systems are required, crane Manufacturer to furnish a coordinated operating system.

2.2 Supplements

.1 Datasheets and any other specific requirements are attached to this Section as Supplements.

2.3 Monorail Beam

.1 Provide rail.

.2 Provide stops and impact-absorbing bumpers at open rail ends.

2.4 Trolley

.1 Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Construct to control deflection of trolley assembly while transmitting the carrying load to running surface.

.2 Where required in the Supplements at the end of this Section, provide trolley drive shaft, driven by an electric motor through a gear reduction unit.

.3 Where required in the Supplements at the end of this Section, provide chain sprocket mounted on shaft. Furnish chain to within 1.5 m of operating floor level. Drive shaft shall drive the trolley wheels through a gear and pinion or spur gear arrangement.

.4 Furnish roller assembly stabilizers on single-girder trolley units to prevent tipping during load pickup.

.5 Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.

.6 Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

.7 Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

.8 Brakes: Suitable for service class and rated torque capacities as specified in ANSI B30.11.

2.5 Hoist

.1 Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position.

.2 Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.

.3 Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.

.4 Brakes: Mechanical and electric load brake and controls, designed in accordance with ANSI 4M, and adjustable to compensate for wear.

.5 Hoisting Machinery: Load chain wheel driven through gear reductions, an electric motor or a hand chain wheel, load blocks, sheaves, chain**,** hook, and hoist braking.

.6 Chain: Non-jamming close-link coil type. Hand chain wheel deep pocket for reception of chain. Hand wheel shall have a guard that prevents chain slipping or jumping. Chain hoists shall have chain storage adequate for storing the full lift length of chain and shall be designed and located to avoid interference while hoisting.

.7 Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load, and positively held in place with locknuts, collars or other devices.

.8 Brakes: In accordance with ANSI HST 1M and 2M, adjustable to compensate for wear, spring set, electric release load brake system, which releases load when drive motor is energized and holds load when the drive motor is de-energized.

2.6 Electrical

.1 Supply electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit.

.2 Electrical: In accordance with CSA C22.1 Section 40 and NFPA 70, NEC Article 610.

.3 Supply motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120-volt ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.

.4 Monorail conductor voltage drops from monorail track supply taps shall permit the hoist and trolley motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

.5 Supply and install Enclosed Bus Bar Conductors: Stainless steel clad hard copper enclosed in insulation. Collector sliding noncopper bearing, carbon shoe type, with adjustable spring tension arms for contact between bus bar and controls. Collector mechanism components aluminum, stainless steel, plastic, or other noncorrosive materials.

.6 Supply and install Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will

dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

.7 Supply and install Cable Reel Conductors: Flexible cable, housed on a circular wheel, counter-torque spring to dispense and retrieve cable, with sag not more than 0.9 m below connection point on hoist or trolley at maximum travel.

.8 Grounding: External in accordance with CSA C22.1 Section 10.

2.7 Controls

.1 Hoist and Trolley: Pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

.2 Pushbuttons: Fully magnetic, plain reversing type, housed in NEMA 250, Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified hoist service class.

.3 Trolley Drives: Soft start controls, 575/230 - volt ac series device, installed between drive motor and motor starter with torque and acceleration rate adjustable, suitable for trolley drive service, and work in conjunction with crane control and pendant or remote system, as specified in the Supplements.

.4 Pendant Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, or as specified in datasheet, with control transformers to supply 120-volt ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 1.8 m intervals. Furnish control station buttons for control of hoist and trolley ON/OFF main line contactor power switch which removes all power from control station.

.5 Remote Control System: Frequency modulated (FM), radio controlled system, belt mounted operator and capable of operating all crane functions.

.6 Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.

.7 Crane motions shall stop automatically when crane can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.

.8 Remote Control Crane Motions: Hook raise and lower, trolley movement, and crane power up and power down. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.

2.8 Accessories

.1 Equipment Identification Plate: 1.6 mm stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location.

.2 Lifting Lugs: Equipment weighing over 45 kilograms.

2.9 Factory Finishing

.1 Prepare and prime coat in accordance with Section 09901, Painting and Finishing – Process Mechanical.

2.10 Source Quality Control

.1 Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

.2 Factory Tests and Adjustments: all equipment furnished.

.3 Factory test report shall include Test Data Sheets.

3. EXECUTION

3.1 Installation

.1 Power feeds and local disconnect to equipment are by Division 16.

.2 Install in accordance with Manufacturer's printed instructions.

.3 Provide lubrication and lubrication fittings.

3.2 Field Finishing

.1 As specified in Section 09901, Painting and Finishing – Process Mechanical

3.3 Field Quality Control

.1 Functional Tests: Conduct on each hoist and monorail system.

.1 Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

.2 Performance Test:

.1 Conduct on each hoist and monorail system.

.2 Conduct electrical tests in accordance with CSA C22.2 No. 33.

.3 Load tests in compliance with OSHA, ANSI B30.11, and ANSI MH27.1

3.4 Manufacturer's Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance for all hoists are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, shall be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	3	100
2	Installation Assistance	2	101
3	Witnessing of Equipment Installation	5	102
4	Assistance in Equipment Performance Testing	5	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each hoist, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data sheets:

.1 Raw Water Pumping Station Area Hoist: CRN-I002

.2 DAF Area Hoists: CRN-P001, CRN-P002, CRN-P004

.3 Residuals Handling Area Hoists: CRN-R001 to CRN-R005

.4 Filter Area Hoists: CRN-F001 to CRN-F008

.5 Fire Pump Room: CRN-H001

END OF SECTION

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 1 – MONORAIL HOIST FOR RAW WATER PUMPING STATION

PARAMETER	VALUE
Tag No. (s)	**CRN-I002**
Type	Wire Rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Electric	Electric
Clearance[1] (mm)	630
Monorail length (m)	11.14
Beam dimensions	W460x74
Monorail beam underside (Geodetic) (m)	249.435
Minimum travel range of hook (Geodetic) (m) Lower Upper	 236.000 249.000
Minimum travel length of cable (m)	14
Minimum hook approach (mm)	340
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	Yes
Hoist power (kW)	11
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc.
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 2 – MONORAIL HOIST FOR DAF INFLUENT GALLERY

PARAMETER	VALUE
Tag No. (s)	**CRN-P001**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Electric	Electric
Clearance[1] (mm)	650
Monorail length (m)	8.375
Beam dimensions	W530x72
Monorail beam underside (Geodetic) (m)	239.870
Minimum travel range of hook (Geodetic) (m) Lower Upper	 233.17 239.22
Minimum travel length of cable (m)	6
Minimum hook approach (mm)	By Manufacturer
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	Yes
Hoist power (kW)	5.4
Trolley power (kW)	0.4
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Enclosure	Squirrel cage
Design standard	Konecranes Canada Inc. Model CXT 4041 – Low Headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

SUPPLEMENT 3 – MONORAIL HOIST FOR DAF INFLUENT GALLERY

PARAMETER	VALUE
Tag No. (s)	**CRN-P002**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Electric	Electric
Clearance[1] (mm)	650
Monorail length (m)	59.087
Beam dimensions	W530x72
Monorail beam underside (Geodetic) (m)	239.870
Minimum travel range of hook (Geodetic) (m) Lower Upper	 231.17 239.22
Minimum travel length of cable (m)	6
Minimum hook approach (mm)	By Manufacturer
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	Yes
Hoist power (kW)	5.4
Trolley power (kW)	0.4
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Enclosure	Squirrel cage
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low Headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 4 – MONORAIL HOIST FOR EAST END DAF GALLERY

PARAMETER	VALUE
Tag No. (s)	**CRN-P004**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Electric	Electric
Clearance[1] (mm)	570
Monorail length (m)	9.4
Beam dimensions	W310x52
Monorail beam underside (Geodetic) (m)	251.326
Minimum travel range of hook (Geodetic) (m) Lower Upper	 236.17 250.50
Minimum travel length of cable (m)	15
Minimum hook approach (mm)	By Manufacturer
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	11
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Enclosure	Squirrel Cage
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low Headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 5 – MONORAIL HOIST FOR RESIDUALS WRT TANKS

PARAMETER	VALUE
Tag No. (s)	**CRN-R001**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	3
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	31.41
Beam dimensions	W410x60 + C250x30
Monorail beam underside (Geodetic) (m)	243.161
Minimum travel range of hook (Geodetic) (m) Lower Upper	 231.25 242.726
Minimum travel length of cable (m)	11.476
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 6 – MONORAIL HOIST FOR RESIDUALS SUPERNATANT PUMPS

PARAMETER	VALUE
Tag No. (s)	**CRN-R002**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Powered	Powered
Clearance[1] (mm)	630
Monorail length (m)	20.3
Beam dimensions	W460x60 + C250x30
Monorail beam underside (Geodetic) (m)	243.113
Minimum travel range of hook (Geodetic) (m) Lower Upper	 239.41 242.48
Minimum travel length of cable (m)	3.07
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	11
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 7 – MONORAIL HOIST FOR RESIDUALS GRAVITY THICKENERS

PARAMETER	VALUE
Tag No. (s)	**CRN-R003, CRN-R004**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	3
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	11.15
Beam dimensions	W410x60 + C250x30
Monorail beam underside (Geodetic) (m)	243.161
Minimum travel range of hook (Geodetic) (m) Lower Upper	 230.748 242.726
Minimum travel length of cable (m)	11.978
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	Yes
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 8 – MONORAIL HOIST FOR RESIDUALS SOUTH GALLERY

PARAMETER	VALUE
Tag No. (s)	**CRN-R005**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Powered	Powered
Clearance[1] (mm)	630
Monorail length (m)	24.92
Beam dimensions	W460x60 + C250x30
Monorail beam underside (Geodetic) (m)	243.113
Minimum travel range of hook (Geodetic) (m) Lower Upper	 236.17 242.483
Minimum travel length of cable (m)	6.313
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	11
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 9 – MONORAIL HOIST FOR BACKWASH SUPPLY PUMP GALLERY – BWS PUMPS

PARAMETER	VALUE
Tag No. (s)	**CRN-F001, CRN-F002**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Powered	Powered
Clearance[1] (mm)	630
Monorail length (m)	7.63
Beam dimensions	W410x60 + C250x30
Monorail beam underside (Geodetic) (m)	236.118
Minimum travel range of hook (Geodetic) (m) Lower Upper	 230.25 235.488
Minimum travel length of cable (m)	5.24
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 10 – MONORAIL HOIST FOR BACKWASH SUPPLY PUMP GALLERY – MANWAYS

PARAMETER	VALUE
Tag No. (s)	**CRN-F003, CRN-F004**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	2
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	7.63
Beam dimensions	W360x51 + C250x30
Monorail beam underside (Geodetic) (m)	236.070
Minimum travel range of hook (Geodetic) (m) Lower Upper	 230.25 235.635
Minimum travel length of cable (m)	5.39
Minimum hook approach (mm)	500
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 11 – MONORAIL HOIST FOR BACKWASH SUPPLY PUMP GALLERY – PROCESS SUMP PUMPS

PARAMETER	VALUE
Tag No. (s)	**CRN-F005**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	2
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	8.1
Beam dimensions	W360x51 + C250x30
Monorail beam underside (Geodetic) (m)	234.170
Minimum travel range of hook (Geodetic) (m) Lower Upper	 228.55 233.735
Minimum travel length of cable (m)	5.19
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 12 – MONORAIL HOIST FOR FILTER PIPE GALLERY – CORRIDOR NO.3 LOADING PLATFORM

PARAMETER	VALUE
Tag No. (s)	**CRN-F006**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	5
Manual or Powered	Powered
Clearance[1] (mm)	630
Monorail length (m)	6.18
Beam dimensions	W530x72
Monorail beam underside (Geodetic) (m)	240.476
Minimum travel range of hook (Geodetic) (m) Lower Upper	 232.8 239.846
Minimum travel length of cable (m)	7.05
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.65
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 5021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 13 – MONORAIL HOIST FOR FILTER PIPE GALLERY – AT EAST CCT ACCESS POINT

PARAMETER	VALUE
Tag No. (s)	**CRN-F007**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	1
Manual or Powered	Powered
Clearance[1] (mm)	375
Monorail length (m)	11.44
Beam dimensions	W310x39 + C250x23
Monorail beam underside (Geodetic) (m)	238.00
Minimum travel range of hook (Geodetic) (m) Lower Upper	 231.00 237.625
Minimum travel length of cable (m)	6.63
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	Yes
Hoist power (kW)	2.2
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 2021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 14 – MONORAIL HOIST FOR FILTER GALLERY – 900 mm VALVES

PARAMETER	VALUE
Tag No. (s)	**CRN-F008**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	2
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	83.5
Beam dimensions	W410x39 + C200x21
Monorail beam underside (Geodetic) (m)	247.85
Minimum travel range of hook (Geodetic) (m) Lower Upper	 239.00 247.415
Minimum travel length of cable (m)	8.42
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

HOIST AND MONORAIL SYSTEMS

SUPPLEMENT 15 – MONORAIL HOIST FOR FIRE PUMP ROOM

PARAMETER	VALUE
Tag No. (s)	**CRN-H001**
Type	Wire rope
Number of rope falls	2
Capacity rating (tonne)	2
Manual or Powered	Powered
Clearance[1] (mm)	435
Monorail length (m)	9.64
Beam dimensions	W410x60 + C310x31
Monorail beam underside (Geodetic) (m)	241.786
Minimum travel range of hook (Geodetic) (m) Lower Upper	 234.5 241.351
Minimum travel length of cable (m)	6.85
Minimum hook approach (mm)	N/A
Hoist control	Two speed
Hoist speed, min (m/min)	1
Hoist speed, max (m/min)	6
Trolley control	Variable speed
Trolley speed, min (m/min)	0
Trolley speed, max (m/min)	20
Remote control (Yes or N/A)	N/A
Hoist power (kW)	9
Trolley power (kW)	0.45
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. Model CXT 4021 – Low headroom
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Handling Material, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the monorail beam.

OVERHEAD TRAVELING CRANES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American National Standards Institute (ANSI):

.1 B30.17, Overhead and Gantry Cranes (Top Running, Single Girder).

.2 B30.2, Overhead and Gantry Cranes (Top Running, Single or Multiple Girder).

.3 B30.10, Hooks.

.4 B30.11, Monorails and Underhung Cranes.

.5 HST 1M, Performance Standard for Electric Chain Hoists

.6 HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.

.7 HST 4M, Overhead Electric Wire Rope Hoists.

.2 Canadian Standards Association:

.1 CSA C22.1, Canadian Electrical Code.

.2 CSA C22.2 No. 33-M1984 (2004), Construction and Test of Electric Cranes and Hoists.

.3 Crane Manufacturer's Association of America (CMAA):

.1 70, Electric Overhead Traveling Cranes.

.2 74, Top Running & Under Running Single Girder. Electric Overhead Traveling Cranes.

.4 Electrical Equipment Manufacturers Advisory Council (EEMAC):

.1 M1-7, Motors and Generators.

.5 National Electrical Manufacturer's Association (NEMA):

.1 MG 1, Motors and Generators.

.2 250, Enclosures for Electrical Equipment (1,000 volts maximum).

.6 National Fire Protection Association (NFPA): National Electrical Code (NEC) (NFPA 70):

.1 Article 610, Cranes and Hoists.

.7 Province of Manitoba Occupational Health and Safety Regulations**.**

1.1 Design Requirements

.1 Top-Running Multiple-Girder Overhead Traveling Crane: CMAA No. 70 and ANSI B30.2 and B30.17.

.2 Top-Running and Underhung Single-Girder Overhead Traveling Cranes: CMAA No. 74, and ANSI B30.11.

.3 Crane Service Class: CMAA No. 74.

.4 Trolley Service Class: CMAA No. 70.

.5 Wire Rope Hoist Service Class: ANSI HST 4M and CMAA No. 70 or No. 74.

.6 Chain Hoist Service Class: ANSI HST 1M and CMAA No. 70 or No. 74.

.7 Hook: ANSI 30.10.

.8 Building Clearances: CMAA No. 70 and No. 74. Where bridge span exceeds 12 metres, increase clearance to 150 mm.

.9 Stress and Safety Factors: CMAA No. 70 and No. 74. Properly select materials of construction for stresses to which subjected.

.10 Safety of Operation, Accessibility, Interchangeability, and Durability of Parts: ANSI B30.2.0 and OSHA requirements. Design equipment for environment operated.

1.2 Submittals

.1 Shop Drawings:

.1 Make, model, weight, horsepower of each equipment assembly, and loads on building steel certified correct by a registered Professional Engineer.

.2 Complete catalog information, descriptive literature, materials of construction, and specifications on bridge drive system, end trucks, runway stops, footwalks and

platforms, wheels, shafting, drive motor, gears and bearing, steel framing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.

.3 Power and control wiring diagrams, including terminals and numbers.

.4 Motor nameplate data in accordance with EEMAC M1-7 and include any motor modifications.

.5 Factory finish system.

.2 Information Submittals:

.1 Factory Functional test Report

.2 Manufacturer's certification of compliance that the factory finish system is identical to the requirements specified herein.

.3 Special shipping, storage and protection, and handling instructions.

.4 Manufacturer's printed installation instructions.

.5 Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

.6 List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.

.7 Operation and Maintenance Manuals.

1.3 Environmental Requirements

.1 Temperature: Maximum 40 degrees C; minimum 5 degrees C.

.2 Humidity: Maximum 100 percent.

1.4 Spare Parts

.1 Furnish for each remote control crane:

.1 One transmitter.

.2 One battery.

2. PRODUCTS

2.1 General

.1 All equipment in Section 14620 – Hoist and Monorail Systems, and 14630 - Overhead Traveling Cranes, are to be supplied by one Manufacturer.

.2 Crane Manufacturer to coordinate equipment requirements with steel structures, panels, drive motor, control panel, trolley and hoist, hoisting cable or chain, hook, crane mounted conductors, rails, stops, and electrical equipment controls.

.3 Where adjustable speed drives or remote control systems are required, crane Manufacturer to furnish a coordinated operating system.

2.2 Supplements

.1 Datasheets and any other specific requirements are attached to this Section as Supplements.

2.3 Runway

.1 Runway rails shall conform to cross-sections and weights per yard as specified in CMAA No. 70 or No. 74. Provide rails, crane stops, and conductors by crane Manufacturer.

2.4 Bridge

.1 Design and supply bridge. Furnish girders from structural shapes proportioned to resist vertical, lateral, and torsional forces.

.2 Construct bridge end trucks in accordance with CMAA No. 70 or No. 74. For Class D and E cranes, designed for impact loading and repeated duty cycle. Furnish end trucks with rail sweeps and impact-absorbing bumpers.

.3 Furnish runway stops attached to resist force applied when contacted and locate at limit of travel of bridge. Runway stops shall not engage the wheels.

.4 Wheels: Rolled or forged steel with treads and flanges heat treated, or cast iron wheels with chilled tread. Minimum tread hardness 200 Brinell. Clearances, wheel loads, and tolerances in accordance with CMAA No. 70 or No. 74. Wheel axles of alloy steel, machined and ground to receive inner bearing races. Use rotating axles and wheels mounted by press fit and keys.

.5 Bridge driving machinery consisting of a cross shaft driven by an electrical motor through a gear speed reducer unit. Cross shaft, high-grade steel, turned, ground, polished, and adequately supported with self-aligning bearings. Shaft diameter to resist torsional strains when bridge is traveling under full load, or when stopped suddenly. Furnish oiltight speed reducer gear case and support on common base with bridge brake.

.6 Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

.7 Bearings: Combination radial and thrust type, double row, spherical ball, either prelubricated and sealed or fitted for pressure lubrication. Pressure lubrication fittings for maintenance accessibility.

.8 Brakes: Electrically operated, adjustable, suitable for the service class indicated, with rated torque capacities as specified in CMAA No. 70 or No. 74.

2.5 Trolley

.1 Frame: Welded steel, cast steel, or ductile iron construction, or a combination thereof. Design to control deflection of trolley assembly while transmitting the carrying load to bridge rails.

.2 Where required in the Supplements at the end of this Section, provide trolley drive shaft, driven by an electric motor through a gear reduction unit.

.3 Where required in the Supplements at the end of this Section, provide chain sprocket mounted on shaft. Furnish chain to within 1.5 meters of operating floor level. Drive shaft shall drive the trolley wheels through a gear and pinion or spur gear arrangement.

.4 Supply and install roller assembly stabilizers on single-girder trolley units to prevent tipping during load pickup.

.5 Wheels: Rolled or forged steel, accurately machined and ground to receive inner bearing races. Furnish alloy steel axles. Rotating axles with wheels mounted press fit and keys, or with keys alone. Minimum tread hardness 210 Brinell.

.6 Drive Gears: Helical, spur or herringbone type, rolled or cast steel, with machine cut teeth.

.7 Bearings: Combination radial and thrust type, double row, angular contact ball bearings or single-row tapered roller bearings. Bearings prelubricated and sealed, or fitted for pressure lubrication. Locate pressure lubrication fittings for accessibility during maintenance.

.8 Brakes: Suitable for service class and rated torque capacities as specified in ANSI B30.11. Furnish stops on trolley rails or beams.

2.6 Hoist

.1 Hoisting machinery shall consist of rope drum driven through gear reductions, load blocks, hook, hoisting rope, sheaves, and hoist braking. Drum size and length sufficient for minimum two turns of cable remaining on drum when hook is at lowest position.

.2 Rope drum and surrounding members constructed to minimize abrasion, crushing or jamming of hoist rope. Load blocks enclosed type. Hoisting rope extra flexible, improved plow steel wire rope, made especially for hoist service.

.3 Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load and positively held in place with locknuts, collars or other devices.

.4 Brakes: Mechanical and electric load brake and controls, designed in accordance with ANSI 4M, and adjustable to compensate for wear.

.5 Hoisting Machinery: Load chain wheel driven through gear reductions, an electric motor or a hand chain wheel, load blocks, sheaves, chain, hook, and hoist braking.

.6 Chain: Nonjamming close-link coil type. Hand chain wheel deep pocket for reception of chain. Hand wheel shall have a guard that prevents chain slipping or jumping. Chain hoists shall have chain storage adequate for storing the full lift length of chain and shall be designed and located to avoid interference while hoisting.

.7 Hook: Construct with sufficient ductility to open noticeably before hook failure, equipped with safety latch, free to rotate 360 degrees with rated load, and positively held in place with locknuts, collars or other devices.

.8 Brakes: In accordance with ANSI 1M and 2M, adjustable to compensate for wear, spring set, electric release load brake system, which releases load when drive motor is energized and holds load when the drive motor is de-energized.

2.7 Electrical

.1 Furnish NEMA 4 electrical equipment including motors, motor starters, pendant control, control systems, wire, and conduit. Bridge conductors may be removed for shipment. Crane wiring by this Division.

.2 Electrical: In accordance with CSA C22.1 Section 40 and NFPA 70, NEC Article 610.

.3 Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and bridge drive applications. Controls with 120-volt ac, microprocessor based, pulsed width modulation design, withstand 45 degree C temperatures, housed in NEMA 250, Type 4 enclosure, and supplied with 200 percent overcurrent protection.

.4 Bridge and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of plus or minus 10 percent, when building supply voltage is at plus or minus 5 percent of design voltage.

.5 Enclosed Bus Bar Conductors: Stainless steel clad hard copper enclosed in insulation. Collector sliding noncopper bearing, carbon shoe type, with adjustable spring tension arms for contact between bus bar and controls. Collector mechanism components aluminum, stainless steel, plastic, or other noncorrosive materials.

.6 Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanently lubricated roller bearings, with monorail support system that will dispense and retrieve

flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

.7 Cable Reel Conductors: Flexible cable, housed on a circular wheel, counter-torque spring to dispense and retrieve cable, with sag not more than 0.9 m below connection point on crane at maximum travel.

.8 Grounding: External in accordance with CSA C22.1 Section 10.

2.8 Controls

.1 Furnish electric cranes with pendant control having momentary contact pushbuttons with a device which will disconnect motors from line on failure of power. Device shall not permit any motor to be restarted until controller handle is brought to the OFF position, or a reset switch or button is operated. Furnish with undervoltage protection as a function of each motor controller, or by magnetic main line contactor.

.2 Controls: Fully magnetic, plain reversing type, housed in NEMA 250, Type 12 enclosure, with contactors of sufficient size and quantity for starting, accelerating, reversing, and stopping duty for specified crane service class.

.3 Bridge and Trolley Drives: Soft start controls, 575/230 - volt ac series device, installed in between drive motor and motor starter with torque and acceleration rate adjustable, suitable for crane service, and work in conjunction with crane controls.

.4 Pushbutton Control Stations: Heavy-duty, oiltight, suspended from trolley, or as specified in datasheet, with control transformers to supply 120-volt ac power to pushbutton control station. Pushbutton enclosure supported with chain or wire rope. Control wire cable attached to support chain or wire rope at not more than 1.8 m intervals. Furnish control station buttons for control of bridge, trolley, and hoist, ON/OFF main line contactor power switch which removes all power from crane and controls.

.5 Remote Control System: Frequency modulated (FM), radio controlled system, belt mounted operator and capable of operating all crane functions.

.6 Control motions indicate direction of resultant crane motion. Furnish spring-loaded switch motions, with return to OFF position when switch is released and designed to prevent runaway crane situations.

.7 Crane motions shall stop automatically when crane can no longer receive remote signals and designed to stop when control signal for any motion becomes ineffective.

.8 Remote Control Crane Motions: Hook raise and lower, trolley movement, bridge movement, and crane power up and power. Furnish an EMERGENCY OFF pushbutton station which will disconnect main line power via a remote switch, and manual reset function to activate all motions after an EMERGENCY OFF event.

2.9 Accessories

.1 Equipment Identification Plate: 1.6 mm stainless steel with 6 mm die-stamped equipment tag number securely mounted in a readily visible location. Mounted on separate components of each crane assembly, to facilitate assembly in the field.

.2 Lifting Lugs: Equipment weighing over 45 kilograms.

2.10 Factory Finishing

.1 Prepare and prime coat in accordance with Section 09901, Painting and Finishing – Process Mechanical.

2.11 Source Quality Control

.1 Factory Inspections: Inspect control panels and equipment for required construction, electrical connection, and intended function.

.2 Factory Tests and Adjustments: all equipment furnished.

.3 Factory test report shall include Test Data Sheets.

3. EXECUTION

3.1 Installation

.1 Power feeds and local disconnect to equipment are by Division 16.

.2 Install in accordance with Manufacturer's printed instructions.

.3 Provide lubrication and lubrication fittings.

3.2 Field Finishing

.1 Equipment as specified in Section 09901, Painting and Finishing – Process Mechanical.

3.3 Field Quality Control

.1 Functional Test: Conduct on each crane.

.1 Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.

.2 Performance Test:

.1 Conduct on each crane.

.2 Conduct electrical tests in accordance with CSA C22.2 No. 33.

.3 Load tests in compliance with OSHA, ANSI B30.11, and ANSI B30.16.

3.4 Manufacturer's Services

.1 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.2 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.3 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.4 The minimum periods of Site attendance for all cranes are identified in the following table along with the form to be completed on each of these trips.

.5 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	3	100
2	Installation Assistance	2	101
3	Witnessing of Equipment Installation	3	102
4	Assistance in Equipment Performance Testing	3	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each hoist, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.2 Data sheets:

.1 Maintenance Workshop Crane: CRN-M001

.2 Raw Water Pumping Station Crane: CRN-I001

.3 DAF Process Gallery Crane: CRN-P003

END OF SECTION

OVERHEAD TRAVELING CRANES

SUPPLEMENT 1 – CRANE FOR MAINTENANCE WORKSHOP

PARAMETER	VALUE
Tag No. (s)	**CRN-M001**
Type	Top-running
Number of rope falls	4
Capacity rating (tonne)	10
Clearance[1] (mm)	610
Runway length (m)	32.82
Runway beams dimensions	W610 x 155 + Bent Plate 100x400x16
Top of runway beams (geodetic) (m)	243.2
Bridge span (m)	8.2
Bridge beam dimensions	By Manufacturer
Minimum travel range of hook (Geodetic) (m) Lower Upper	 236.17 242.67
Minimum travel length of cable (m)	6.5
Minimum hook approach (mm)	By Manufacturer
Bridge control	Variable speed
Bridge speed, min / max (m/min)	0/32 m/min
Hoist type	Electric, wire rope
Hoist control	2 speed
Hoist speed, min /max (m/min)	1/6 m/min
Trolley control	Variable speed
Trolley speed, min /max (m/min)	0/20 m/min
Remote control (Yes or N/A)	N/A
Bridge Power (kW)	0.92 kW
Hoist power (kW), min/max	1.6/11 kW
Trolley power (kW)	0.8 kW
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc. , Crane - CXTSk10t, Hoist - CXT50410100P55FDL0F
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Material Handling, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the travelling beam.

SUPPLEMENT 2 – CRANE FOR RAW WATER PUMPING STATION

PARAMETER	VALUE
Tag No. (s)	**CRN-I001**
Type	Top Running Single Girder Travelling Bridge Crane
Number of rope falls	2
Capacity rating (tonne)	5
Clearance[1] (mm)	650
Runway length (m)	27.9
Runway beams dimensions	W460 x 82 + Bent plate 100x400x16
Top of runway beams (geodetic) (m)	249.435
Bridge span (m)	7.5
Bridge beam dimensions	By Manufacturer
Minimum travel range of hook (Geodetic) (m) Lower Upper	 242.000 249.000
Minimum travel length of cable (m)	7
Minimum hook approach (mm)	1100
Bridge control	Variable speed
Bridge speed, min / max (m/min)	0 / 20
Hoist type	Electric, wire rope
Hoist control	Two speed
Hoist speed, min /max (m/min)	1 / 6
Trolley control	Variable speed
Trolley speed, min /max (m/min)	0 / 20
Remote control (Yes or N/A)	Yes
Bridge Power (kW)	0.92
Hoist power (kW)	11 ±
Trolley power (kW)	0.65 ±
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc.
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Material Handling, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the underside of the travelling beam.

OVERHEAD TRAVELING CRANES

SUPPLEMENT 3 – CRANE FOR DAF PROCESS GALLERY – OVER FLOC TANKS

PARAMETER	VALUE
Tag No. (s)	**CRN-P003**
Type	Under Running Single Girder Crane
Number of rope falls	2
Capacity rating of crane (tonne)	2
Number of hoists and trolleys per crane	2
Capacity of hoists and trolleys (tonne), each	2
Clearance[1] (mm)	535
Runway length (m)	100
Runway beams dimensions	W410x39 + C200x21
Top of runway beams (geodetic) (m)	249.030
Bridge span (m)	11.3
Bridge beam dimensions	By Manufacturer
Minimum Travel Range of Hook (Geodetic) (m) Lower Upper	 239.0 248.2
Minimum travel length of cable (m)	9
Minimum hook approach (mm)	By Manufacturer
Bridge control	Two speed
Bridge speed, min / max (m/min)	8 / 32
Hoist type	Electric chain
Hoist control	Two speed
Hoist speed, min /max (m/min)	1.2 / 5
Trolley control	Variable speed
Trolley speed, min /max (m/min)	5 / 20
Remote control (Yes or N/A)	Yes
Bridge Power (kW), two motors, one for each side	2 X 0.37
Hoist power (kW)	1.03
Trolley power (kW)	0.2
Voltage (V/phase/frequency Hz)	575 / 3 / 60
Design standard	Konecranes Canada Inc., Model XCU
Acceptable Manufacturers	Konecranes Canada Inc., Kaverit Steel and Crane, P&H Material Handling, Mannesman Demag

Note 1. The clearance is defined as the distance from hook saddle to top of flange on the top side of the travelling beam.

GENERAL MECHANICAL PROVISIONS

1. GENERAL

1.1 Intent

.1 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.2 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.3 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximize head room and with minimum interference with other services. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at the Contractor's cost.

.4 Install equipment to provide access and ease of maintenance.

.5 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the City. Uncrate equipment, move in place and install complete; start-up and test.

1.2 Coordination of Work

.1 Cooperate and coordinate with other trades on the Site.

.2 Where dimensional details are required, work with the applicable architectural and structural Drawings.

.3 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Metric Conversion

.1 All units in this Division are expressed in International System (SI) units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, supply and install equivalent nominal Imperial sized pipe as indicated in the table, and supply and install at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved pipes for equipment where nominal SI Metric pipes are provided, the Contractor shall supply and install at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (in) (NPS)	mm (in) (NPS)	mm (in) (NPS)
3 (1/8)	65 (2-1/2)	375 (15)
6 (1/4)	75 (3)	450 (18)
10 (3/8)	100 (4)	500 (20)
15 (1/2)	125 (5)	600 (24)
20 (3/4)	150 (6)	750 (30)
25 (1)	200 (8)	
30 (1-1/4)	250 (10)	
40 (1-1/2)	300 (12)	
50 (2)		

.5 Metric Duct Sizes:

.1 The metric duct sizes are expressed as 25 mm = 1 in.

1.4 Shop Drawings

.1 Provide printed copies of Shop Drawing, in accordance with Section 01300, for all scheduled equipment and as specified in specific equipment sections of this Specification.

.2 Identify materials and equipment by manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Contract Administrator's office. Operating and Maintenance (O&M) Manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.4 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes. Provide additional information as specified in specific equipment sections of this specification.

.5 Installed materials and equipment shall meet specified requirements regardless of whether or not Shop Drawings are reviewed by the Contract Administrator.

.6 Do not order equipment or material until the Contract Administrator has reviewed and returned Shop Drawings.

.7 Submit shop drawings for pipe and equipment labels.

.8 Retain one (1) copy of Shop Drawings On-Site for review.

1.5 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Provide openings and holes required in precast members for mechanical work. Cast holes 100 mm (4 in) or larger in diameter. Field-cut smaller than 100 mm (4 in).

.4 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective section.

1.6 Equipment Protection and Clean-Up

.1 Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.7 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: National Electrical Manufacturer's Association (NEMA), Electrical and Electronic Manufacturer's Association of Canada (EEMAC), CSA, Canadian Electrical Code (CEC) Part 1, Institute of Electrical and Electronic Engineers (IEEE) and American National Standards Institute (ANSI). All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive (variable frequency drive) shall be inverter only rated.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment specifications. Provide all motors with thermal overload protection.

.5 Motors less than 0.37 kW shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless indicated otherwise.

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.10 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.11 Minimum certified motor efficiency shall be as outlined in Manitoba Hydro's latest high efficiency motor incentives program, or the following table, whichever indicates the higher minimum efficiency.

MINIMUM EFFICIENCY (%) *

kW	3600 RPM	1800 RPM	1200 RPM	900 RPM
0.75	75.5	82.5	80.0	74.0
1.1	82.5	84.0	85.5	77.0
1.5	84.0	84.0	86.5	82.5
2.3	85.5	87.5	87.5	84.0
3.7	87.5	87.5	87.5	85.5
5.6	88.5	89.5	89.5	85.5
7.5	89.5	89.5	89.5	88.5
11.3	90.2	91.0	90.2	88.5
15	90.2	91.0	90.2	89.5
18.9	90.5	91.7	91.3	89.6
22.5	90.8	91.9	91.4	90.7
30	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8
100	93.0	93.7	93.5	92.7

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

.12 Acceptable Manufacturers

.1 GE Canada.

.2 Leeson Canada.

.3 Reliance Electric.

.4 MagneTek.

.5 Siemens Energy and Automation, Inc., Motors and Drives Division.

.6 Baldor.

.7 U.S. Electrical Motors.

.8 TECO-Westinghouse Motor Co.

.9 Toshiba International Corp., Industrial Division.

1.8 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

.1 Volume and splitter dampers

.2 Controls, coils and terminal units

.3 Filters

.4 Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be Underwriters Laboratories (UL)-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm (8 in x 8 in) for cleanout, 300 mm x 300 mm (12 in x 12 in) for hand 600 mm x 600 mm (24 in x 24 in) for body access minimum.

.5 Provide UL-listed fire rated access doors installed in rated wall and ceilings.

1.9 Miscellaneous Metals

.1 Supply and install all necessary miscellaneous metals to hang or support materials, equipment and provide access for Work under this Contract.

.2 All miscellaneous metals shall be prime painted for interior applications and galvanized for exterior applications.

1.10 Pipe Sleeves

.1 Minimum thickness: 4.7 mm.

.2 Seep Ring:

.1 Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 4.7 mm minimum thickness.

.2 Outside Diameter: Unless otherwise shown, 75 mm greater than pipe sleeve outside diameter.

.3 Continuously fillet weld on each side all around.

.4 Factory Finish:

.3 Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.

.1 Hot-dip applied, meeting requirements of American Society for Testing and Materials (ASTM) A153/A153M.

.2 Electroplated zinc or cadmium plating is unacceptable.

.3 As specified in Section 15200-000 – Process Piping.

.4 Below Grade or in Submerged or Damp Environments: Shop-lined and coated.

.1 Lining and coating in accordance with Section 09870 – Coating Systems for Steel Tanks and Pipes.

1.11 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

2. PRODUCTS

2.1 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 gauge) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 Roof flashing and curb cants will be provided by Others.

.4 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.5 Vertical flange section of roof jacks shall be screwed to face of curb.

2.2 Identification Labels

.1 Pipe Labels:

.1 Labels:

.1 Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.

.2 Provided with ties or straps for pipes of 150 mm and over diameter.

.3 Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.

.2 Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.

.3 Letters and Arrows: Black on OSHA safety yellow background.

.4 Colour Field and Letter Height: Meet ASME A13.1.

.5 Message: Piping system name as indicated in Piping Schedule – Section 15200-00S.

.6 Acceptable Manufacturers:

.1 Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.

.2 Seton Identification Products; Ultra-mark Pipe Markers.

.2 Equipment Labels:

.1 Applies to equipment with assigned tag numbers, where specified.

.2 Letters: Black engraved, 19 mm high minimum.

.3 Background: White.

.4 Materials:

.1 Rigid laminate.

.2 Multi-layered acrylic.

.5 Furnish 25 mm margin with holes at each end of label, for mounting. On fibreglass labels, furnish grommets at each hole.

.6 Size:

.1 50 mm minimum and 75 mm maximum high, by 350 mm minimum and 450 mm maximum long.

.2 Furnish same size base dimensions for all labels.

.7 Message: Equipment names and tag numbers as used in sections where equipment is specified.

.8 Manufacturers:

.1 Brady Signmark.

.2 Seton Identification Products.

3. EXECUTION

3.1 General

.1 Do not install water piping immediately over or within a 1 metre horizontal clearance of any electrical panel, motor starter, or HCP. Where piping must be located within these zones, install piping inside a PVC conduit or shield the electrical device to protect it from direct water access.

3.2 Identification

.1 Pipe Labels:

.1 Provide and install pipe labels and flow direction arrows. Locate at connections to equipment, valves, or branching fittings at wall boundaries.

.2 At intervals along piping not greater than 6 m on center with at least one label applied to each exposed horizontal and vertical run of pipe.

.3 At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.

.4 Supplementary Labels: Provide to City those listed in Piping Schedule that do not receive arrows.

.5 Application: To pipe only after painting in vicinity is complete or as approved by Contract Administrator.

.6 Installation: In accordance with manufacturer's instructions.

.2 Equipment Labels:

.1 Locate and install on equipment or concrete equipment base.

.2 Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

.3 Valves:

.1 Provide 20 mm (3/4 in) diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to Contract Administrator. Include copies in O&M Manuals.

.4 Controls:

.1 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.2 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this division with lamacoid plates having 6 mm (1/4 in) minimum letter size. Identification to state equipment controlled.

.5 Heating, Ventilation, Fire Protection:

.1 Identify the usage of duct access panels with self adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	Color	Letters
Cleaning and service access	yellow	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.2 All ductwork to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Mixed Air	M.A.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

.3 Identify the location of the following items of equipment, which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green
Balancing Dampers	blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

3.3 Colour Coding Schedule

.1 Coordinate colour coding of piping and equipment with Work of Division 9.

END OF SECTION

PIPING SUPPORT SYSTEMS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American Society for Testing and Materials (ASTM):

.1 A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.

.2 Building Officials and Code Administrators (BOCA): Basic Building Code.

.3 International Conference of Building Officials (ICBO): Uniform Building Code.

.4 National Building Code of Canada (NBC)

.5 Manufacturers' Standardization Society (MSS):

.1 SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 SP 69, Pipe Hangers and Supports - Selection and Application.

.3 SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.

1.2 Submittals

.1 Shop Drawings:

.1 Drawings of piping support system, locating each support, brace, hanger, guide, component, and anchor. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

.2 Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.

.2 Information Submittals: Maintenance information on piping support system.

1.3 Qualifications

.1 Piping support systems shall be designed and Shop Drawings prepared and sealed by a Professional Engineer registered in the Province of Manitoba.

1.4 Design Requirements

.1 General:

.1 Seismic Load: Seismic performance category forces with seismic loads in accordance with local codes.

.2 Design, size, and locate piping support systems throughout facility, whether shown or not.

.3 Piping smaller than 750 mm: Supports are shown only where specific types and locations are required; additional pipe supports may be required.

.4 Piping 750 mm and larger: Support systems have been designed for piping shown.

.5 Meet requirements of MSS SP 58, MSS SP 69, and MSS SP 89, or as modified by this Section.

.2 Pipe Support Systems:

.1 Support Load: Dead loads imposed by weight of pipes filled with intended service commodity except air and gas pipes, plus insulation.

.2 Maximum Support Spacing and Minimum Rod Size:

.1 Mild Steel or Ductile Iron Piping:

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
25 mm & smaller	1.8 m	6.25 mm
32.5 mm through 62.5 mm	2.4 m	6.25 mm
75 mm & 100 mm	3.0 m	9.5 mm
150 mm	3.6 m	9.5 mm
200 mm	3.6 m	12.5 mm
250 mm & 300mm	4.3 m	15.9 mm
350 mm	4.8 m	19.1 mm
400 mm & 450 mm	4.8 m	22.2 mm
500 mm	5.4 m	25.4 mm
600 mm	5.4 m	31.7 mm

Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
762 mm & larger	As shown on Drawings	As shown on Drawings

.2 Copper Piping:

.1 Maximum Support Spacing: 0.61 m less per size than listed for steel pipe, with 25.4 mm and smaller pipe supported every 1.5 m.

.2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.

.3 Plastic and Fiberglass Piping:

.1 Maximum support spacing: As recommended by Manufacturer for flow temperature in pipe.

.2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.

.4 Stainless Steel Piping:

SST Pipe Size	Maximum Support/ Hanger Spacing	Minimum Rod Size Single Rod Hangers
25 mm through 100 mm	2.4 m	6.25 mm
150 mm	2.4 m	9.5 mm
200 mm & 250 mm	3.0 m	12.5 mm
300 mm	3.0 m	12.5 mm
350 mm& 400 mm	3.6 m	15.9 mm
450 mm & 500 mm	4.3 m	19.1 mm
600 mm	4.3 m	22.2 mm

.3 Framing Support System:

.1 Beams: Size such that beam stress does not exceed 172 MPa and maximum deflection does not exceed 1/240 of span.

.2 Column Members: Size in accordance with Manufacturer's recommended method.

.3 Support Loads: Calculate using weight of pipes filled with intended service commodity.

.4 Maximum Spans:

.1 Steel and Ductile Iron Pipe, 75 mm diameter and larger: 3 m centres, unless otherwise shown.

.2 Other Pipelines and Special Situations: May require supplementary hangers and supports.

.4 Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

.5 Vertical Sway Bracing: 3 m maximum centres, or as shown.

.6 Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show that they are adequate for additional load, or if they are strengthened to support additional load.

2. PRODUCTS

2.1 General

.1 When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated by catalogs.

.2 Special support and hanger details are shown for cases where standard catalog supports are inapplicable.

.3 Materials: In accordance with Tables 1 and 2, in this Section.

2.2 Hangers

.1 Clevis Type: MSS SP 58 and SP 69, Type 1 or 6.

.1 Anvil; Figure 104 or 260.

.2 B-Line; Figure B3198 or B3100.

.2 Hinged Split-Ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.

.1 Anvil; Figure 104.

.2 B-Line; Figure B3198H.

.3 Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

.4 Attachments:

.1 I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.

.2 Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

2.3 Saddle Supports

.1 Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.

.1 Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.

.1 Anvil; Figure 259.

.2 B-Line; Figure B3090.

.2 Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp.

.1 Anvil; Figure 264.

.2 B-Line; Figure B3093.

2.4 Wall Brackets

.1 Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).

.1 Anvil; Figure 199.

.2 B-Line; Figure B3067.

.2 One-Hole Clamp: Anvil; Figure TBA

.3 Channel Type:

.1 Unistrut.

.2 Anvil; Power-Strut.

.3 B-Line; Strut System.

.4 Aickinstrut (Fibreglass Reinforced Polymer (FRP)).

2.5 Pipe Clamps

.1 Riser Clamp: MSS SP 58 and SP 69, Type 8.

.1 Anvil; Figure 261.

.2 B-Line; Figure B3373.

2.6 Channel Type Support Systems

.1 Channel Size: 2.7 mm (12 gauge), 41.3 mm wide minimum steel, 27.6 mm wide minimum FRP.

.2 Members and Connections: Design for all loads with safety factor of 5.

.3 Manufacturers:

.1 B-Line; Strut System.

.2 Unistrut.

.3 Anvil; Power-Strut.

.4 Aickinstrut (FRP System).

2.7 Accessories

.1 Insulation Shields:

.1 Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.

.2 Acceptable Manufacturers:

.1 Anvil; Figure 167.

.2 B-Line; Figure B3151.

.2 Welding Insulation Saddles:

.1 Type: MSS SP 58 and SP 69, Type 39.

.2 Acceptable Manufacturers:

.1 Anvil; Figure Series 160.

.2 B-Line; Figure Series B3160.

.3 Vibration Isolation Pads:

.1 Type: Neoprene Waffle.

.2 Acceptable Manufacturers:

.1 Mason Industries; Type W.

.2 Korfund; Korpad 40.

2.8 Intermediate Pipe Guidelines

.1 Piping 150 mm and Smaller:

.1 Type: Pipe clamp with oversized pipe sleeve to provide minimum 3.2 mm clearance.

.2 Acceptable Manufacturers:

.1 B-Line; B3148 or B3180.

.2 Anvil; Figure 103.

.2 Piping 200 mm and Larger:

.1 Type: Specially formed U-bolts with double nuts to provide 6.4 mm minimum clearance around pipe.

.2 U-Bolt Stock Size:

.1 200 mm Pipe: 15.9 mm.

.2 250 mm Pipe: 19.1 mm.

.3 300 mm Through 400 mm Pipe: 22.2 mm.

.4 450 mm Through 762 mm Pipe: 25.4 mm.

2.9 Pipe Alignment Guides

.1 Type:

.1 Piping 200 mm and smaller: Spider or sleeve type.

.2 Piping 250 mm and larger: Roller type.

.2 Manufacturers:

.1 Flexonics.

.2 Anvil.

.3 B-Line.

2.10 Pipe Anchors

.1 Type: Anchor chair with U-bolt strap.

.2 Acceptable Manufacturers:

.1 Anvil; Figure TBA

.2 B-Line; Figure B3147A or B3147B.

3. EXECUTION

3.1 Installation

.1 General:

.1 Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise.

.2 Support piping connections to equipment by pipe support and not by equipment.

.3 Support large or heavy valves, fittings, and appurtenances independently of connected piping.

.4 Support no pipe from pipe above it.

.5 Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.

.6 Do not install pipe supports and hangers in equipment access areas or bridge crane runs.

.7 Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.

.8 Install lateral supports for seismic loads at all changes in direction.

.9 Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.

.10 Repair mounting surfaces to original condition after attachments are made.

.2 Standard Pipe Supports:

.1 Horizontal Suspended Piping:

.1 Single Pipes: Adjustable swivel-ring, split-ring, or clevis hangers.

.2 Grouped Pipes: Trapeze hanger systems.

.3 Furnish galvanized steel protection shield and oversized hangers for insulated pipe.

.4 Furnish precut sections of rigid insulation with vapor barrier at hangers for insulated pipe.

.2 Horizontal Piping Supported From Walls:

.1 Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.

.2 Stacked Piping:

.1 Wall mounted framing system and clips acceptable for piping smaller than 75 mm minimal diameter.

.2 Piping clamps that resist axial movement of pipe through support not acceptable.

.3 Wall mounted piping clips not acceptable for insulated piping.

.3 Horizontal Piping Supported From Floors:

.1 Stanchion Type:

.1 Pedestal type; adjustable with stanchion, saddle, and anchoring flange.

.2 Use yoked saddles for piping whose centreline elevation is 450 mm or greater above floor and for exterior installations.

.3 Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.

.2 Floor Mounted Channel Supports:

.1 Use for piping smaller than 75 mm nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.

.2 Attach channel framing to floors with anchor bolts.

.3 Attach pipe to channel with clips or pipe clamps.

.3 Concrete Cradles: Use for piping larger than 75 mm along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.

.4 Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.

.5 Standard Attachments:

.1 To Concrete Ceilings: Concrete inserts.

.2 To Steel Beams: I-beam clamp or welded attachments.

.3 To Wooden Beams: Lag screws and angle clips to members not less than 62 mm thick.

.4 To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.

.6 Existing Walls and Ceilings: Install as specified for new construction, unless shown otherwise.

.3 Intermediate and Pipe Alignment Guides:

.1 Provide pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.

.2 Guide piping on each side of expansion joint or loop at 4- and 14-pipe diameters from each joint or loop.

.3 Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

.4 Accessories:

.1 Insulation Shield: Install on insulated nonsteel piping. Oversize rollers and supports.

.2 Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.

.3 Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.

.4 Dielectric Barrier:

.1 Install between carbon steel members and copper or stainless steel pipe.

.2 Install between stainless steel supports and nonstainless steel ferrous metal piping.

.5 Electrical Isolation: Install 6.4 mm by 75 mm neoprene rubber wrap between submerged metal pipe and oversized clamps.

3.2 Field Finishing

.1 Paint supports in accordance with Section 09901 – Painting and Finishing – Process Mechanical.

3.3 Hanger Materials

.1 Select hanger material in accordance with the following tables:

Table 1
Nonchemical Areas

Exposure Conditions	Hanger Material
Office areas	Galvanized steel or precoated steel
Shops and warehouse areas	Galvanized steel or precoated steel
Pipe Galleries	Galvanized steel or precoated steel
Process areas: high humidity	Stainless steel or FRP
Process areas: wetted or submerged	Stainless steel or FRP

Notes:
1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653, Class G90, or hot-dip galvanized after fabrication to ASTM A123.

Table 2
Chemical Areas

Exposure Conditions	Hanger for Direct Exposure	Hanger for Remote Exposure
Aqua Ammonia	Stainless steel	Precoated steel
Ferric Chloride	FRP	Precoated steel
Hydrogen Peroxide	Stainless steel	Precoated steel
Polymers	FRP	Precoated steel
Sodium Hydroxide	Stainless steel	Precoated steel
Sodium Hypochlorite	FRP	Precoated steel
Sulfuric Acid	Stainless steel	Precoated steel

Notes:
1. Direct exposure includes entire area within containment area; area within 6 m of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653, Class G90, or hot-dip galvanized after fabrication to ASTM A123.

END OF SECTION

MECHANICAL THERMAL INSULATION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ASHRAE: 90.1, Energy-Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.2 ASTM:

.1 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.2 C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

.3 C195, Standard Specification for Mineral Fiber Thermal Insulating Cement.

.4 C335, Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.

.5 C411, Test Method for Hot Surface Performance of High Temperature Thermal Insulation.

.6 C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

.7 C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

.8 C547, Standard Specification for Mineral Fiber Pipe Insulation.

.9 C552, Standard Specification for Cellular Glass Thermal Insulation.

.10 C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.11 C592, Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Meshed Covered) (Industrial Type).

.12 C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.13 C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.14 C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

.15 D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

.16 D2310, Standard Classification for Machine-Made 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.

.17 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.18 E96, Test Methods for Water Vapor Transmission of Materials.

.19 G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

.20 G22, Standard Practice for Determining Resistance of Plastics to Bacteria.

.3 Association of the Non-Woven Fabrics Industry, INDA.

.4 MSS:

.1 SP 58, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 SP 69, Pipe Hangers and Supports - Selection and Application.

.5 NFPA:

.1 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

.4 259, Standard Test Method for Potential Heat of Building Materials.

.6 UL: 723, UL Standard for Safety Test for Surface Burning Characteristics of Building Materials.

.7 TIAC, Thermal Insulation Association of Canada – Standards Manual for Mechanical Insulation.

.8 CAN/ULC-S102, Standard Method & Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 Definitions

.1 Piping: Includes fittings, flanges, valves, special pipe fittings, drains, vents and similar items, both indoors and outdoors.

.2 Ducting: Includes fittings, drains, accessories and similar items.

.3 Concealed: Insulated mechanical services and equipment above suspended ceilings and non-accessible chases and furred spaces.

.4 Exposed: Not concealed.

1.3 Submittals

.1 Action Submittals: Product description, list of materials and thickness for each service or equipment scheduled, locations, and Manufacturer's installation instructions.

.2 Informational Submittals:

.1 Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.4 Quality Assurance

.1 Materials furnished under this Specification shall be standard, catalogued products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

.2 Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than five (5)years.

.3 UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.5 Coordination

.1 Some piping will be electrically heat traced by Division 16. Coordinate installation of insulation with installation of heat tracing.

1.6 Delivery, Storage, and Handling

.1 Manufacturer's Stamp or Label:

.1 Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site for use must have Manufacturer's stamp or label attached, giving name of Manufacturer, brand, and description of material.

.2 Insulation packages and containers shall be marked "asbestos-free."

2. PRODUCTS

2.1 General

.1 Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

.2 Insulation shall conform to referenced publications and specified temperature ranges and densities in kg/m^3.

.3 Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

.4 Fire Resistance:

.1 Insulation, adhesives, vapour barrier materials and other accessories, except as specified herein, shall be noncombustible.

.2 Use no fugitive or corrosive treatments to impart flame resistance.

.3 Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.

.4 Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with ASTM E84 (NFPA 255) methods.

.5 Materials exempt from fire-resistant rating:

.1 Nylon anchors.

.2 Treated wood inserts.

.6 Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:

.1 Polyurethane insulation.

.2 PVC casing.

.3 Fibreglass-reinforced plastic casing.

2.2 Pipe Insulation

.1 Type P1—Fibreglass (ASTM C547, Class 1):

.1 Fibreglass, UL-rated, preformed, sectional rigid, with factory-applied ASJ composed of reinforced Kraft paper and aluminum foil laminate. Jacket shall have self-sealing lap to facilitate closing longitudinal and end joints.

.2 Minimum density: 64 kg/m^3.

.3 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.

.4 Temperature Rating: -28 to 260 ^oC.

.5 Fitting Insulation: wired-in-place premolded insulation or mitred secments, or soft fibreglass insulation inserts, covered with 0.51 mm minimum thickness PVC fitting covers.

.6 Acceptable Manufacturers:

.1 CertainTeed; 500° Snap-On ASJ/SSL

.2 Schuller (Manville); Micro-Lok 650 with AP-T jacket.

.3 Owens/Corning Fiberglass; 25 ASJ/SSL.

.4 Knauf Pipe Insulation; ASJ/SSL.

.2 Type P3—Elastomeric (ASTM C534):

.1 Flexible, closed cell elastomeric, nominal 96 kg/m^3 density,

.2 Thermal conductivity K factor 0.039 W/m°C maximum at 24°C mean per ASTM C177 or ASTM C518.

.3 Temperature Rating: -40 to 104 ^oC.

.4 Flame Spread Rating: Less than 25 per ASTM E84.

.5 Fitting Insulation: same as pipe.

.6 Acceptable Manufacturers:

.1 Armstrong; AP Armaflex.

.2 Schuller (Manville); Aerotube II.

.3 Nomaco; Therma-Cel.

.4 Rubatex; R-180-FS.

.3 Type P4—Cellular Glass:

.1 Temperature Rating: -179 to 482 ^oC.

.2 Acceptable Manufacturers:

.1 Pittsburg Corning Foamglass.

2.3 Duct Insulation

.1 Type D1—Blanket (ASTM C553, Type 1, Class B3):

.1 Fibreglass, nominal 16 kg/m^3 density blanket, K factor 0.045 W/m°C maximum at 24°C mean, with factory-applied foil-scrim-kraft vapour barrier jacket, for temperatures to 121°C.

.2 Acceptable Manufacturers:

.1 CertainTeed; Standard Duct Wrap.

.2 Schuller (Manville); Microlite.

.3 Owens/Corning Fiberglass; RFK-75.

.4 Knauf; Ductwrap.

.2 Type D2—Board:

.1 Fibreglass, minimum 44 kg/m^3 density board, K factor 0.033 W/m°C maximum at 24°C mean, with factory-applied FSK vapour barrier jacket, for temperatures from 38°C to 454°C.

.2 Acceptable Manufacturers:

.1 CertainTeed; IB 850.

.2 Knauf; Elevated Temperature Board.

.3 Owens/Corning Fiberglass; TIW.

.4 Schuller (Manville); 1000 Series Spin-Glass.

.3 Type D3—Liner (ASTM C1071, Type 1):

.1 Fibreglass, nominal 24 kg/m^3 density liner, K factor 0.036 W/m°C maximum at 24°C mean, black composite coated surface exposed to airstream to prevent erosion of glass fibres, for temperatures to 121°C.

.2 Liquid water repellency rating not less than 4 when tested in accordance with INDA IST 80.6.

.3 Potential heat value not exceeding 8140 kJ/kg when tested in accordance with NFPA 259 and meeting the classification of "Limited Combustible" as defined by NFPA 90A.

.4 Maximum rated velocity not less than 30 m/s when tested in accordance with ASTM C1071.

.5 Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139, G21 and G22.

.6 Acceptable Manufacturers:

.1 CertainTeed; Toughgard.

.2 Schuller (Manville); Linacoustic.

.3 Knauf; Duct Liner M.

2.4 Equipment Insulation

.1 Type E1—Elastomeric (ASTM C534):

.1 Flexible, closed-cell elastomeric, nominal 96 kg/m^3 density, K factor 0.039 W/m°C maximum at 24°C mean.

.2 Acceptable Manufacturers:

.1 Armstrong; Armaflex II.

.2 Schuller (Manville); Aerotube II.

.3 Nomaco; Therma-Cel.

.4 Rubatex; R-180-FS.

2.5 Insulation Finish Systems

.1 Type F1—PVC:

.1 PVC jacketing, white, for straight run piping and fitting locations, temperatures to 70°C.

.2 Acceptable Manufacturers:

.1 Knauf; Proto.

.2 Schuller (Manville); Zeston.

.2 Type F2—Paint:

.1 Acrylic latex paint, white, and suitable for outdoor use.

.2 Acceptable Manufacturers:

.1 Armstrong; WB Armaflex finish.

.2 Rubatex; 374, white finish.

.3 Type F3—Aluminum:

.1 Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.4 mm thickness, with smooth mill finish.

.2 Moisture Barrier: Provide factory applied moisture barrier, consisting of 18 kg kraft paper with 1 mil thick low density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.

.3 Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, specialty fittings, etc.

.4 Manufacturer:

.1 Permaclad

.2 Childers

.3 Insul-Coustic

.4 RPR Products

3. EXECUTION

3.1 Application of Piping Insulation

.1 Install insulation products in accordance with Manufacturer's written instructions, and in accordance with recognized industry practices.

.2 Apply insulation over clean, finish painted, and dry surfaces.

.3 Install insulation after piping system has been pressure tested and leaks corrected.

.4 Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

.5 Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

.6 Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

.7 Maintain integrity of vapour-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal all butt ends of chilled water and condensate drain piping insulation at fittings with white vapour barrier coating.

.8 Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapour barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

.9 Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

.10 Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation. Insulation shall be continuous through pipe supports and hangers.

.11 Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

.12 Insulate valve bodies, flanges, and pipe couplings.

.13 Insulate and vapour seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

.14 Do not insulate flexible pipe couplings and expansion joints.

.15 Do not allow insulation to cover nameplates or code inspection stamps.

.16 Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

.17 Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

.18 Cold Surfaces: Provide continuous vapour seal on insulation on cold surfaces where vapour barrier jackets are used.

.19 Placement:

.1 Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.

.2 Insulate valves and fittings with sleeved or cut pieces of same material.

.3 Seal and tape joints.

.20 Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

.21 Roof Drains: Insulated entire length of roof drain piping.

.22 Vapour Barrier:

.1 Provide continuous vapour barrier at joints between rigid insulation and pipe insulation.

.2 Install vapour barrier jackets with pipe hangers and supports outside jacket.

.3 Do not use staples and screws to secure vapour sealed system components.

3.2 Installation of Ductwork Insulation

.1 General: Install insulation products in accordance with the Manufacturer's written instructions and in accordance with recognized industry practices.

.2 Install insulation materials with smooth and even surfaces.

.3 Clean and dry ductwork prior to insulation. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

.4 Maintain integrity of vapour-barrier on ductwork insulation and protect it to prevent puncture and other damage. Tape all punctures.

.5 Seal longitudinal and circumferential joints with FSK tape, and finish with fibreglass mesh fabric embedded in vapour barrier mastic.

.6 Extend ductwork insulation without interruption through walls, floors, and similar ductwork penetrations, except where otherwise indicated.

.7 Except as otherwise indicated, omit external insulation on ductwork where internal insulation or sound absorbing linings have been installed.

.8 Refer to Section 15810 – Metal Ductwork and Accessories, for installation of internal duct liner.

3.3 Installation of Equipment Insulation

.1 Application Requirements: Insulate where external surface temperature of equipment is below ambient temperature in the space, including surfaces that have a recognized possibility for condensation.

.2 Install equipment thermal insulation products in accordance with Manufacturer's written instructions and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

.3 Install insulation materials with smooth and even surfaces and on clear and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gaping joints and excessive voids resulting from poor workmanship.

.4 Maintain integrity of vapour-barrier on equipment insulation and protect it to prevent puncture and other damage.

.5 Provide removable insulation sections to cover parts of equipment that must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames, and accessories.

.6 Replace damaged insulation that cannot be repaired satisfactorily, including units with vapour barrier damage and moisture-saturated units.

.7 Avoid using scrap pieces of insulation where larger sheets will fit.

3.4 Installation of Insulation Finish Systems

.1 Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

.2 Secure circumferential joints with preformed snap straps containing weatherproof sealant.

.3 On exterior piping, apply coating over insulation and vapour barrier to prevent damage when aluminum fitting covers are installed.

.4 Do not use screws or rivets to fasten the fitting covers.

.5 Install removable prefabricated aluminum covers on exterior flanges and unions.

.6 Caulk and seal all exterior joints to make watertight.

3.5 Piping Insulation Requirements

.1 Install insulation over entire length of pipes unless noted otherwise.

.2 Condensate Drain:

.1 Type P3, elastomeric.

.2 12 mm thickness for pipe sizes up to 65 mm ID.

.3 20 mm thickness for pipe sizes over 65 mm ID.

.3 Cooling Water and Condenser Water (CWR, CWS and CDR, CDS):

.1 Type P1, fibreglass.

.2 40 mm thickness for all pipe sizes.

.4 Potable Cold Water (DCW, PW), Plant Service Water (PSW):

.1 Type P3, elastomeric.

.2 12 mm thickness for pipe sizes 32 mm and smaller.

.3 25 mm thickness for pipe sizes larger than 32 mm.

.5 Hot Water (DHW, TDW):

.1 Type P1, fibreglass.

.2 25 mm thickness for all pipe sizes.

.6 Roof Drain (RD, SWD), Chilled Water (CHR, CHS) and Overflow Drain Sump:

.1 Type P3, elastomeric.

.2 25 mm thickness.

.7 Caustic (CS)

.1 Type P1, fibreglass.

.2 Temperature: 25 to 90^{o}C.

.3 40 mm thickness.

.8 Air Scour (AS)

.1 Type P1, fibreglass.

.2 Temperature: 15 to 120^{o}C.

.3 25 mm thickness.

.4 Supply and install insulation on all exposed Air Scour (AS) piping above floor elevation 245.000 and below elevation 236.000.

.9 Pipe Hangers:

.1 Type P1, Fibreglass: UL-rated, preformed rigid pipe insulation inserts of thickness equal to adjoining insulation, 250 mm in length, with factory-applied, vinyl-coated and embossed vapour barrier jacket with self-sealing lap.

.2 Type P3, Elastomeric: Rigid insulation section with 225 mm long, 1.6 mm thick (16 gauge) galvanized steel saddle.

3.6 Ductwork Insulation Requirements

.1 Mechanically Cooled Supply Air:

.1 Type D2, board.

.2 40 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.2 Mechanically Heated Supply Air (system MUA-H021):

.1 Type D2, board.

.2 40 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.3 Mechanically Cooled and Heated Supply Air (Air handling unit serving the Administration area):

.1 Type D3, liner.

.2 40 mm thickness.

.4 Exhaust Air (1200 mm from external wall or roof):

.1 Type D2, board.

.2 40 mm thickness.

.5 Mechanically Cooled and Heated Supply and Return Air; (Water source heat pump units):

.1 Type D3, liner.

.2 40 mm thickness.

.6 Unheated Supply Air:

.1 Type D3, liner.

.2 25 mm thickness.

.3 Insulate full length of ductwork, unless otherwise noted.

.7 Sheet Metal Plenums:

.1 Type D3, liner.

.2 40 mm thickness.

3.7 Equipment Insulation Requirements

.1 Cooling Water Pumps and Plate-and-Frame Heat Exchanger:

.1 Type E1, elastomeric.

.2 20 mm thickness.

3.8 Insulation Finish Requirements

.1 Piping, Duct, and Equipment Insulation (Concealed Areas): Factory finish.

.2 Piping Insulation (Exposed to View, Indoors):

.1 Type F1, PVC, unless noted otherwise.

.3 Ductwork Insulation (Exposed to View, Indoors):

.1 Factory finished.

.4 Equipment Insulation (Exposed to View, Indoors):

.1 Type F3, Aluminum.

.5 Piping Insulation (Outdoors):

.1 Type F2, paint (for use with Type P3, elastomeric).

.2 Type F3, aluminum.

.6 Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.9 Field Quality Control

.1 Test factory-applied materials assembled. Field-applied materials may be tested individually.

END OF SECTION

PLUMBING PIPING

1. GENERAL

1.1 Scope of Work

.1 The Section covers the requirements for supply and installation of building services piping. Building services piping includes:

.1 Drainage, vent and waste piping.

.2 Trap primer piping.

.3 Potable water piping including hot and cold water.

.4 Stormwater drainage piping.

.5 Plant service water piping.

.6 Natural gas piping.

.7 Sanitary sump pump discharge piping.

.8 Water systems for building heating, including heat pumps.

.9 Compressed air piping.

.10 Instrument air piping for sizes larger than 13 mm.

.11 Condensate drains from heating and ventilation equipment.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ANSI:

.1 B2.1.001, Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel.

.2 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.3 B16.3, Malleable Iron Threaded Fittings.

.4 B16.5, Pipe Flanges and Flanged Fittings.

.5 B16.9, Factory-Made Wrought Steel Buttwelding Fittings.

.6 B16.12, Cast Iron Threaded Drainage Fittings.

.7 B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

.2 ASTM:

.1 A47, Standard Specification for Ferritic Malleable Iron Castings.

.2 A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

.3 A74, Standard Specification for Cast Iron Soil Pipe and Fittings.

.4 A105/A105M, Standard Specification for Forgings, Carbon Steel, for Piping Components.

.5 A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

.6 A181/A181M, Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping.

.7 A197/A197M, Standard Specification for Cupola Malleable Iron.

.8 A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

.9 A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.10 A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.

.11 A536, Standard Specification for Ductile Iron Castings.

.12 A563, Standard Specification for Carbon and Alloy Steel Nuts.

.13 A861, Standard Specification for High-Silicon Iron Pipe and Fittings.

.14 B32, Standard Specification for Solder Metal.

.15 B61, Standard Specification for Steam or Valve Bronze Castings.

.16 B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.17 B75, Standard Specification for Seamless Copper Tube.

.18 B88, Standard Specification for Seamless Copper Water Tube.

.19 B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

.20 B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.

.21 B139, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.

.22 B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

.23 B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.

.24 B306, Standard Specification for Copper Drainage Tube.

.25 C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

.26 D1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.

.27 D1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120.

.28 D2000, Standard Classification System for Rubber Products in Automotive Applications.

.29 D2466, Standard Specification for PVC Plastic Pipe Fittings.

.30 D2564, Standard Specification for Solvent Cements for PVC Plastic Piping Systems.

.31 D2855, Standard Practice for Making Solvent-Cemented Joints with PVC Pipe and Fittings.

.32 E438, Standard Specification for Glasses in Laboratory Apparatus.

.33 F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.

.3 AWWA:

.1 C104/A21.4, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.

.2 C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 75 mm. Through 1200 mm for Water and Other Liquids.

.3 C111/A21.11, Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

.4 C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

.5 C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.

.6 C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.

.7 C207, Standard for Steel Pipe Flanges for Waterworks Service-Sizes 100 mm Through 3,600 mm

.8 C606, Grooved and Shouldered Joints.

.9 C651, Disinfecting Water Mains.

.4 CSA B149.1, Natural Gas and Propane Installation Code.

.5 Cast Iron Soil Pipe Institute (CISPI): 301, Specification for Cast Iron No-Hub Pipe.

.6 NSF:

.1 60, Drinking Water Treatment Chemicals - Health Effects.

.2 61, Drinking Water System Components - Health Effects.

.7 Conform with the Plumbing Code and the requirements of Provincial and local authorities having jurisdiction.

1.3 Submittals

.1 Shop Drawings:

.1 Product data sheets.

.2 Drawings showing changes in location of fixtures or equipment that are advisable in the opinion of Contractor.

.2 Quality Control Submittals:

.1 Changes in location of equipment or piping that affect connecting or adjacent Work, before proceeding with the Work.

.2 Complete list of products proposed for installation.

.3 Test records produced during testing.

2. PRODUCTS

2.1 Piping

.1 Refer to Section 15200-00S – Piping Schedule for piping materials and testing requirements.

.2 Piping Legend: Refer to Section 15200-00L – Piping Service Legend.

.3 Piping Material: Refer to Piping Data Sheets:

.1 Section 15100-01 – Data Sheet – Polyvinyl Chloride Drain Waste and Vent (PVC-DWV) Pipe and Fittings.

.2 Section 15100-02 – Data Sheet-Cast Iron Soil Pipe and Fittings.

.3 Section 15100-03 – Data Sheet – Copper Drainage and Vent Pipe and Fittings.

.4 Section 15100-10 – Data Sheet- Galvanized Steel Drain and Vent Pipe and Fittings.

.5 Section 15200-13 – Data Sheet- Copper and Copper Alloy Pipe, Tubing and Fittings.

.6 Section 15200-21 – Data Sheet- Carbon Steel Pipe and Fittings-Natural Gas Service.

2.2 Pipe Hangers and Supports

.1 As specified in Section 15060 – Piping Support Systems.

2.3 Insulation

.1 As specified in Section 15085 – Mechanical Thermal Insulation.

2.4 Valves

.1 Gate Valves:

.1 50 mm and Smaller for Water, Air, Drainage and Sewage Services: Use valve type V100 as specified in Section 15202, Process Valves and Operators.

.2 65 mm and Larger for Water, Air, Drainage and Sewage Services: Use valve type V108 as specified in Section 15202, Process Valves and Operators.

.2 Ball Valves:

.1 50 mm and Smaller for Water and Air Services: Use valve type V300 as specified in Section 15202, Process Valves and Operators.

.2 65 mm to 100 mm for Water Service: Use valve type V308 as specified in Section 15202, Process Valves and Operators.

.3 50 mm and Smaller for Drainage and Sewage Service: Use valve type V307 as specified in Section 15202, Process Valves and Operators.

.4 Thermoplastic Ball Valves 75 mm and Smaller for Water Service: Use valve type V330 as specified in Section 15202, Process Valves and Operators.

.3 Butterfly Valves:

.1 65 mm and Larger: Use valve type V513 as specified in Section 15202, Process Valves and Operators.

.4 Globe Valves:

.1 65 mm and Smaller: Use valve type V236 as specified in Section 15202, Process Valves and Operators.

.2 75 mm through 200 mm: Use valve type V210 as specified in Section 15202, Process Valves and Operators.

.5 Angle Valves:

.1 50 mm and Smaller: Use valve type V201 as specified in Section 15202, Process Valves and Operators.

.6 Check Valves:

.1 50 mm and Smaller for Water, Sewage and Drainage Service: Use valve type V602 as specified in Section 15202, Process Valves and Operators.

.2 65 mm and Larger for Water Service: Use valve type V604 as specified in Section 15202, Process Valves and Operators.

.3 100 mm and Larger for Drainage and Sewage Service: Use valve type V632 as specified in Section 15202, Process Valves and Operators.

.7 Flap Valves:

.1 150 mm to 450 mm: Use valve type V695 as specified in Section 15202, Process Valves and Operators.

.8 Water Pressure Reducing Valves 12 mm through 65 mm:

.1 Spring controlled, with a neoprene diaphragm.

.2 Sizes and Ratings:

.1 PRV-x: 12 mm IPS, maximum 0.5 L/s, with inlet pressure 700 kPa; outlet pressure 400 kPa.

.3 Acceptable Manufacturers:

.1 Fisher; Type 75

.2 Watts; No. 223 S

.9 Gauge Cock Valves 3 mm To Class 125:

.1 Bronze body, hexagon male and female ends and tee head.

.2 Rated for 125-pound SWP.

.3 Acceptable Manufacturers:

.1 Ernst Gage Co.

.2 Lunkenheimer.

.10 Manual Air Vent Valves:

.1 With coin-operated air vent.

.2 Acceptable Manufacturers:

.1 Bell & Gossett; No. 4V.

.2 Dole; No. 9.

.11 Solenoid Valves:

.1 Two-way, full line size, normally open, 1035 kPa body pressure, 35 kPa operating differential, for use with cold water.

.2 Suitable for 115 V, 60 Hz, ac power supply.

.3 Manufacturers:

.1 Asco Valve Inc..

.2 Parker Skinner Valve.

.12 Thermostatic Mixing Valve Assembly:

.1 Function: Provide tempered water at 0.2 to 3.15 L/s.

.2 Components:

.1 High flow mixing valve for 1 to 3.15 L/s.

.2 Low flow mixing valve for 0.2 to 0.45 L/s.

.3 Pressure reducing valve.

.4 Pressure gauge.

.5 Isolation valve.

.6 Thermometer.

.7 Pipe fittings.

.8 Heavy-gauge steel cabinet with access door and Manufacturer's standard baked enamel finish.

.3 Inlets: One each, 20 mm NPT, cold and hot water.

.4 Outlets: 25 mm NPT.

.5 Self-contained; no electrical requirements.

.6 Performance: With 60°C hot inlet and 16°C cold inlet, deliver 38°C at inlet pressures between 210 and 690 kPa. Set outlet at 35°C.

.7 Manufacturer and Product:

.1 Powers Process Controls; Series 430/420 Hydroguard.

.2 Symmons, Temcontrol Series.

.13 Pressure Reducing Valve (for compressed air purge of electrical panels), PRV-1:

.1 Service: Instrument air.

.2 Inlet pressure: 500 to 860 kPa(g).

.3 Outlet pressure: 40 kPa (adjustable).

.4 Connections: 6 mm or 12 mm NPT.

.5 Integral pressure gauge, kPa units.

.6 Body material: brass, bronze or stainless steel.

.7 Acceptable Manufacturers:

.1 Fisher Controls, 67C series

.2 Control Air Inc.

.14 Needle Valve (for compressed air purge of electrical panels): Use valve type V950, 6 mm, as specified in Section 15202, Process Valves and Operators.

2.5 Miscellaneous Piping Specialties

.1 Strainers for Water Service:

.1 Iron body, Y-pattern, Class 125 rated, with screwed bronze or bolted iron cap.

.2 Screen: Heavy-gauge stainless steel or monel, 30-mesh.

.3 Acceptable Manufacturers:

.1 Crane; No. 988-1/2.

.2 Asco Red Hat.

.2 Flexible Connectors for Stainless Steel Gas Lines:

.1 Corrugated, Type 316 stainless steel hose, with 250 mm live length and Type 316 stainless steel male NPT pipe connectors at each end.

.2 Manufacturers:

.1 Flexonics Ltd.

.2 North American Mfg. Co.

.3 Vacuum Breakers 50 mm and Smaller:

.1 Angle type, as required.

.2 Manufacturers:

.1 Febco.

.2 Watts.

.4 Water Hammer Arrestors:

.1 Acceptable Manufacturers:

.1 J. R. Smith; Series 5000.

.2 Zurn Z-1700.

.3 P.P.P. Inc., SS Series

.5 Water Hose:

.1 Furnish six 15 m length(s) of 25 mm and three 15 m length(s) of 40 mm, Ethylene Propylene Diene Monomer (EPDM) black cover and EPDM tube, reinforced with two textile braids. Furnish each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.

.2 Rated minimum working pressure of 1369 kPa.

.3 Manufacturers:

.1 Goodyear.

.2 Boston.

.6 Hose Nozzles:

.1 For each hose, furnish 25 mm and 40 mm cast brass satin finish nozzle(s) with adjustable fog, straight-stream, and shut-off features and rubber bumper. Provide nozzle(s) with female NST hose thread.

.2 Manufacturers:

.1 Croker.

.2 Elkhart.

.7 Sleeves:

.1 Acceptable Manufacturers:

.1 J. R. Smith; Figure 1720.

.2 Zurn Z198.

.8 Insulating Dielectric Unions and Flanges:

.1 Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.

.2 Unions 50 mm and Smaller: Screwed or solder-joint type.

.3 Unions 65 mm and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.

.4 Manufacturers:

.1 Epco Sales, Inc., Cleveland, OH.

.2 Capitol Insulation Unions.

.9 Joint Solder: 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.

.10 Pipe Joint Sealer: Compound insoluble in water or Teflon tape; approved by NSF 61 for use in potable water.

.11 Rubber Gaskets: ASTM C564.

2.6 Metering and Measuring Devices

.1 Thermometers:

.1 Adjustable angle, bi-metal type with 225 mm case and scale range in degrees C, as shown.

.2 Furnish with 90 mm stem length and separable NPT brass thermowell.

.3 Manufacturers:

.1 Weksler.

.2 Trerice.

.2 Pressure Gauges:

.1 90 mm gauge size, 0 to 690 kPa, 0 to 1103 kPa range, steel case, glass crystal, brass movement, and 6 mm NPT lower connection.

.2 Furnish with 6 mm brass gauge cock.

.3 Acceptable Manufacturers:

.1 Ashcroft; Type 1000.

.2 Marsh; J80.

3. EXECUTION

3.1 Piping Material Selection

.1 Select piping material for the various services based on Section 15200-00S – Piping Schedule.

3.2 General

.1 Field Obstructions:

.1 Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.

.2 Do not modify structural components, unless approved by Contract Administrator.

.2 Sleeves:

.1 Pipe sizes shown are nominal sizes, unless shown or specified otherwise.

.2 Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.

.3 Provide pipes passing through finished walls with chrome-plated canopy flanges.

.3 Concrete Encasement: Encase in concrete all plumbing piping installed under the building foundations or below the lower floor slab of the building, unless otherwise noted.

.4 Provide unions in piping systems at connections to equipment.

.5 Provide insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection, as shown.

.6 Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent to nearest drain with copper tubing.

3.3 Installation

.1 Steel Pipe:

.1 Ream, clean, and remove burrs and mill scale from piping before making up.

.2 Seal joint with pipe joint sealer of Teflon tape.

.2 Copper Tubing:

.1 Cut tubing square and remove burrs.

.2 Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.

.3 Prevent annealing of fittings and hard-drawn tubing when making connections.

.4 Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

.3 Rigid PVC or CPVC:

.1 Cut, make up, and install in accordance with pipe Manufacturer's recommendations.

.2 Ream, clean, and remove burrs from cut ends before joining pipe.

.3 Lay in trench by snaking pipe from one side to the other.

.4 Offset: as recommended by Manufacturer for maximum temperature variation between time of solvent welding and final use.

.5 Do not lay pipe when temperature is below 4.5°C or above 32°C when exposed to direct sunlight.

.6 Shield ends to be joined from direct sunlight prior to and during laying operation.

.7 Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.

.4 Water System Balancing: Provide a qualified Professional Engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

.5 Water Hammer Arrestors:

.1 Install in piping systems where shown on Drawings and adjacent to pieces of equipment where quick closing valves are installed.

.2 Install at all emergency safety showers and eyewashes.

.3 Size and install in accordance with Plumbing and Drainage Institute Standard PDI-WH201.

.4 Shock arresters to have access panels or to be otherwise accessible.

.6 Valves: Install in accordance with Manufacturer's recommendations.

.7 Miscellaneous Piping Specialties: Install in accordance with Manufacturer's recommendations.

.8 Metering and Measuring Devices: Install in accordance with Manufacturer's recommendations.

.9 Condensate Drains: Discharge to sanitary drainage system. Provide continuous slope.

3.4 Sanitary Drain, Waste and Vent Piping

.1 Installation:

.1 Set piping occurring above floor slab true and plumb.

.2 Set exposed risers as close to walls as possible.

.3 Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.

.4 Extend vents minimum 305 mm above roof.

.5 Supply and install cleanouts where shown and where required by code.

3.5 Water Piping

.1 Water supply piping includes potable water, plant service water, hot and cold domestic water, trap primer water, building heating system water.

.2 Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer's recommended flow.

.3 Except where otherwise shown on Drawings, do not run water piping through electrical rooms, stairwells, or immediately over or within a 1 m horizontal clearance of electrical panels, motor starters, or environmental control panels.

.4 Hose Valves and Hydrants: Attach handle with setscrew and provide Manufacturer's recommended gravel fill around drain hole of post hydrants.

.5 Provide valve operators with position indicators, where indicated, to show position of valve disc or plug.

.6 Provide bypass with globe valve for emergency throttling around each reducing valve.

.7 Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.

.8 Provide manual air vents at high points in domestic hot water system.

3.6 Gas Piping

.1 Slope piping 2% downward in direction of flow toward respective drip traps.

.2 Provide union adjacent to each flexible connector hose.

.3 Purge natural gas piping before putting into service using carbon dioxide or nitrogen gas to not more than the maximum positive pressure setting of the gas burner excess pressure relief valve but not exceeding 20 kPa whichever is less.

3.7 Insulation

.1 As specified in Section 15085 – Mechanical Thermal Insulation.

3.8 Hangers and Supports

.1 As specified in Section 15060 – Piping Support Systems.

.2 Hanger Rod Sizing and Spacing: As specified in National Plumbing Code, Table 2.3.4.5.

3.9 Interim Cleaning

.1 As specified in Section 15200-000 – Process Piping.

3.10 Testing

.1 As specified in Section 15200-000 – Process Piping and Section 15200-00S – Piping Schedule.

3.11 Cleaning and Disinfection

.1 As specified in Section 15200-000 – Process Piping and Section 15200-00S – Piping Schedule.

3.12 Protection of Installed Work

.1 Protective Covers:

.1 Provide covers over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.

.2 Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.

3.13 Field Finishing

.1 Paint the exterior of ferrous metal piping, copper piping, iron piping and PVC piping in accordance with Section 09901 – Painting and Finishing – Process Mechanical**.**

.2 Repair any damage to coating and lining on embedded pipes and sleeves.

END OF SECTION

DATA SHEET – POLYVINYL CHLORIDE DRAIN WASTE AND VENT (PVC-DWV) PIPE AND FITTINGS

Item	Size	Description
Pipe and Fittings	All	PVC-DWV Schedule 40 non-pressure application, Class 12454B conforming to ASTM D2665, ANSI/NSF Standard 14 system, and CSA B181.2.
Joints	All	Solvent cemented conforming to ASTM D2855 except where connection to equipment may require future removal.
Solvent Cement	All	As recommended by the pipe and fitting Manufacturer conforming to ASTM D2564.

END OF SECTION

DATA SHEET – CAST IRON SOIL PIPE (CISP) AND FITTINGS

Item	Size	Description
Pipe	150 mm and smaller	Hubless, CISPI 301, service weight, no-hub ends, CSA B70.
	200 mm and larger	Hub and spigot, ASTM A74, service weight, single hub and spigot, CSA B70.
Joints	150 mm and smaller	Compression: Neoprene sealing sleeve with 0.6 mm (24 gauge) Type 304 stainless steel shield and clamp assembly.
	200 mm and larger	Rubber gaskets, ASTM C564.
Fittings	All	ASME B16.4; ASME 16.12, CISPI 301, CSA B70.
Coating	All	Bituminous-coated inside and out; marked with Manufacturer's name or trademark and CISPI symbol.

END OF SECTION

DATA SHEET - COPPER DRAINAGE AND VENT PIPE AND FITTINGS

Item	Size	Description
Tubing	75 mm and smaller	Copper drainage tube, DWV type conforming to ASTM B306.
Fittings	75 mm and smaller	Wrought copper or wrought copper alloy solder joint drainage fittings, DWV, conforming to ANSI B16.22.
Solder	All	Wire solder (95% tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Solder joints in accordance with ANSI B16.22.

END OF SECTION

DATA SHEET - GALVANIZED STEEL DRAIN AND VENT PIPE AND FITTINGS

Item	Size	Description
Pipe	100 mm & smaller	Carbon steel, galvanized, furnace butt welded, ASTM A53, Grade F, Schedule 40.
Fittings	100 mm & smaller	Cast iron, galvanized, screwed drainage fittings, ASTM A126, Class B, dimensions conforming to ANSI B16.12. Malleable iron, ductile iron, or galvanized steel grooved end galvanized drainage fittings, materials conforming to ASTM A47, ASTM A536, and ASTM A53, Grade B, respectively, permitted in aboveground roof drainage systems only.
Joints	100 mm & smaller	Screwed threads conforming to ASTM A47; made with Teflon tape or joint compound that is insoluble in water. Grooved end joints are permitted in aboveground roof drainage systems.

END OF SECTION

HYDRONIC SPECIALTIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ASME.

.2 NEMA:

.1 MG 1-12.53a, Motors and Generators.

.2 NEMA 250.

.3 OSHA.

.4 Canadian Standard Association: CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

.5 ULC.

1.2 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature including make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 Certificate of Satisfactory Installation, Form 102, as per Section 01650 - Equipment Installation.

.3 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

2. PRODUCTS

2.1 Supplements

.1 See supplements to this section for additional product information.

2.2 Hydronic Specialties

.1 Diaphragm Expansion Tank (ETNK-H020):

.1 Steel diaphragm type with heavy-duty butyl rubber bladder.

.2 ASME rated for 115 ^{o}C working temperature and 862 kPa working pressure.

.3 Conform to the requirement of CSA B51.

.4 Performance Data:

.1 Total Capacity: 127 litres.

.2 Acceptance Capacity: 42 litres.

.3 Dimensions: Approximately 406 mm diameter by 1073 mm long.

.4 Precharge Pressure: 103.4 kPa

.5 Manufacturers and Product:

.1 S.A. Armstrong, AX-60

.2 Bell & Gossett.

.3 Amtrol

.2 Pot Feeder: Bypass feeder for injecting chemical treatment into closed loop systems.

.1 Feeder Working Pressure: 1034 kPa.

.2 Acceptable Manufacturers:

.1 Aqua-Serv; Type AV, 20 litre capacity.

.2 Neptune; Model VS-BF**,** 20 litre capacity.

.3 Balancing Valve (CBV):

.1 Bronze body, globe type, and carbon filled TFE seat rings (15 mm to 75 mm).

.2 Heavy duty cast iron, bronze seat, bronze disc with EPDM seal insert, and stainless steel stem (100 mm to 300 mm).

.3 Hand adjusted.

.4 Graduated dial indicator.

.5 Line size (unless otherwise indicated).

.6 Integral valved readout ports.

.7 Adjustable memory stop.

.8 Drain connection.

.9 Preformed insulation.

.10 Acceptable Manufacturers:

.1 S.A. Armstrong; Type CBV

.2 Bell & Gossett

.3 Taco.

.4 Triple Duty Valve

.1 Combination valve incorporating three functions in one body: tight shut-off, spring-closure type silent non-slam check and flow measurement ports.

.2 Ductile iron body.

.3 6mm NPT measuring ports, one on each side of valve seat, with Nordel check valves and gasketted caps.

.4 Bronze plug disc, stainless steel stem.

.5 Pre-formed removable PVC insulation jacket.

.6 Manufacturers:

.1 S.A. Armstrong, Model FTV-S

.2 Approved equal.

.5 Bimetallic Industrial Thermometer

.1 Precision calibrated bimetallic sensing element

.2 Silicone dampened coil

.3 Adjustable angle type with swivel union connection

.4 125mm diameter face

.5 Hermetically sealed stainless steel case

.6 Double strength glass window

.7 External recalibrator

.8 Stem:

.1 Stainless steel

.2 Length as recommended by manufacturer for pipe or duct size and insulation thickness at installed thermometer location

.9 When installed on piping, installed with thermowell furnished by same Manufacturer as thermometer

.10 When installed on ductwork, installed with mounting flange and adapter hub furnished by same manufacturer as thermometer

.11 Maximum 1 degree per scale division of Celsius scale

.12 Accurate to plus or minus 1 percent of full scale in accordance with ASME B40.200

.13 Celsius only scale

.14 Temperature range: 0 to 80 degrees C

.15 Manufacturers and Products:

.1 H. O. Trerice Co.; B8

.2 Ashroft

.3 Weksler.

.6 Pressure Gauge

.1 Bourdon tube sensing element

.2 Range:

.1 0 to 890 kPa

.2 Indelibly mark ranges with black figures on a white background

.3 Connection: 6mm male NPT.

.4 Case: Painted steel, stainless steel, fiberglass reinforced polypropylene, or aluminum

.5 Wetted Parts: Bronze, brass, stainless steel, or monel

.6 Ring: Stainless steel or fiber glass reinforced polypropylene

.7 Window: Acrylic or glass

.8 Dial Face:

.1 100mm diameter, minimum

.2 Black figures on white background

.9 Accuracy: Plus or minus 1 percent of full scale in accordance with ASME B40.100

.10 Temperature Rating: 121 degrees C, minimum

.11 Manufacturers:

.1 H.O. Trerice Co.

.2 Ashroft

.3 Weksler.

.7 Pressure and Temperature Test Plug:

.1 Brass body.

.2 7 mm NPT.

.3 Removable threaded brass protective cap.

.4 Dual neoprene core rated for 93 ^{o}C.

.5 Manufacturer and Product: Sisco; Model BNE-025.

.8 Air Separator:

.1 Full-line size (50 mm and larger), without strainer.

.2 Tangential construction.

.3 Steel tank with stainless steel collector tube.

.4 ASME constructed for 862 kPa operating pressure.

.5 Blowdown connection.

.6 Acceptable Manufacturers:

.1 Bell & Gossett; Rolairtrol.

.2 Taco; 400 Series.

.3 S.A. Armstrong.

HYDRONIC SPECIALTIES

.9 Pressure Relief Valve:

.1 ASME rated.

.2 Bronze body

.3 EPDM diaphragm

.4 Maximum operating temperature: 40 degree C

.5 Maximum operating pressure: 862 kPa

.6 Relief Pressure: 227 kPa

.7 Manufacturers and products:

.1 Bell & Gossett; Type 790 or 1170

.2 Taco; No. 321

.10 Automatic Air Vent: Brass body with nonferrous internals.

.1 Acceptable Manufacturers: For 1034 kPa maximum operating pressure and 115 ^{o}C maximum operating temperature.

.1 Hoffman; No. 78.

.2 Bell & Gossett; No. 87.

.3 S.A. Armstrong, No. 71.

.2 Acceptable Manufacturers: For 240 kPa maximum working pressure and 110 ^{o}C maximum operating temperature.

.1 Hoffman; No. 77.

.2 Bell & Gossett; No. 67.

.3 S.A. Armstrong, No. 67.

.11 Manual Air Vents: Brass body with nonferrous internals.

.1 Maximum Operating Pressure: 1340 kPa.

.2 Maximum Operating Temperature: 107 ^{o}C.

.3 Manufacturer and Product: Bell & Gossett; No. 4V.

.12 Drain and Charge Valve: Brass body with nonferrous internals.

.1 Maximum Operating Pressure: 862 kPa.

.2 Maximum Operating Temperature: 115 ^{o}C.

.3 Acceptable Manufacturers:

.1 Bell & Gossett; Drain-O-Tank DT-2.

.2 Taco; Air-Scoop.

.13 Pressure Reducing Valve:

.1 20 mm cast iron body.

.2 Brass mounted.

.3 Integral strainer and anti-siphon check valve.

.4 Factory Pressure Setting: 83 kPa with adjustable range of 55 to 170 kPa.

.5 Acceptable Manufacturers:

.1 Bell & Gossett; No. 12.

.2 Taco; No. 329.

2.3 Hydronic System Circulating Water Pumps

.1 Vertical Inline Pump:

.1 Vertical split-coupled type with rigid spacer type coupling.

.2 Ductile Iron casing with flanged suction and discharge, drilled and tapped for seal flush and gauge connection.

.3 Impeller: Bronze, Fully enclosed. Dynamically balanced.

.4 Stainless steel shaft.

.5 Mechanical seal: Stainless steel outside multi-spring balanced type with Viton secondary seal. Bronze gland plate with stainless steel hardware.

.6 Oil-lubricated ball bearings.

.7 Motor:

.1 1,800 rpm.

.2 Totally enclosed fan cooled.

.8 Bearings and impeller removable without disturbing piping.

.9 Bearing assembly interchangeable with several pump sizes.

.10 Furnish removable coupling shield.

.11 Construct for 860 kPa working pressure.

.12 Acceptable Manufacturers:

.1 S.A. Armstrong; Series 4300

.2 Bell & Gossett.

.3 Taco.

2.4 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm (16 gauge) stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.5 Finishes

.1 Manufacturers' standard machine enamel finish.

3. EXECUTION

3.1 Balancing Devices

.1 Install balancing devices with unrestricted flow and straight pipe for four pipe diameters up and downstream per manufacturer’s recommendations.

.2 Install well tappings and fittings for control sensors.

3.2 Vertical Inline Pumps

.1 Install in accordance with manufacturer's written directions**.**

.2 Install pumps on concrete bases provided by Others. Coordinate location of pump bases. Concrete base size shall be at least 100 mm wider and longer than the pump and driver base, and a minimum of 100 mm thick.

.3 Anchor pump securely in place.

3.3 Access and Clearance Considerations

.1 Obstructions: Drawings do not attempt to show exact details of piping. Anticipate and work around obstructions.

.2 Cover piping installed across aisles or other main access walkways with a protective checkered plate steel ramp, pitched a maximum of 2:12 to allow safe wheeled or foot traffic, and paint with a prime coat and two finish coats of Safety Yellow. Support ramp from the floor, and do not rest ramp directly on pipe.

.3 Install specialties with suitable access clearances for maintenance or removal of replaceable components. Provide necessary couplings or flanges to maintain or remove specialties without removing connecting appurtenances.

.4 Provide an alternate safe means of access where equipment requiring periodic maintenance cannot be reached by walkways because of substitution of equipment or interference with ductwork, piping, or other mechanical conflicts resulting from construction. These may include:

.1 Overhead platform with stairway or ladder access and safety railings or handholds.

.2 Walk-through duct plenums with hinged access doors.

.3 Other means as necessary to meet OSHA Standards for safe maintenance procedures.

3.4 Cleaning and Adjusting

.1 Cleanup:

.1 Thoroughly clean all parts of the installation and remove refuse material at completion of the Work.

.2 Check belt-drive tensions and alignments.

.3 Lubricate motors and bearings in accordance with manufacturer's service manuals prior to equipment startup.

.2 Repair Work: Perform repair work of existing facilities affected by mechanical work performed under this section. Include such items as:

.1 Replacement of ceiling tiles or plaster removed or damaged for access to ceiling.

.2 Patching walls and ceilings for piping and ductwork penetrations.

.3 Repair of concrete or asphalt paving removed for pipe access.

.4 Other repairs due to extension and remodeling of existing mechanical systems.

3.5 Supplements

.1 The supplement listed below, following "End of Section" are a part of this Specification.

.1 15120-01 Circulating Pump (HWP) Schedule.

END OF SECTION

CIRCULATING PUMP (HWP) SCHEDULE
15120-01

Equipment Tags	AREA SERVED	PUMP TYPE	PERFORMANCE DATA			MOTOR DATA				PHYSICAL DATA				SA ARMSTRONG MODEL NO.	REMARKS
			CAPACITY		SPEED		RPM	VOLT	PH	WEIGHT	DIMENSIONS mm				
			L/s	Head kPa	RPM	kW				kg	L	W	H		
HWP-H007	Cooling Water Circulating	VERTICAL INLINE	16.9	240	1800	7.46	1800	575	3	155	533	422	902	4300-3X3X10	
HWP-H008	Cooling Water Circulating (standby)	VERTICAL INLINE	16.9	240	1800	7.46	1800	575	3	155	533	422	902	4300-3X3X10	Standby
HWP-H016	Heat Pump Water Circulating	VERTICAL INLINE	16.9	396	1800	14.91	1800	575	3	282	648	486	1086	4300-3X3X13	
HWP-H017	Heat Pump Water Circulating (Standby)	VERTICAL INLINE	16.9	396	1800	14.91	1800	575	3	282	648	486	1086	4300-3X3X13	Standby

REMARKS:

PROCESS PIPING

1. GENERAL

1.1 Scope

.1 This Section covers the supply, installation, testing, cleaning and placing into operation of all process piping systems including fittings.

1.2 References

.1 The following is a list of standards which may be referenced in this Section and any supplemental Data Sheets:

.1 ANSI:

.1 A21.52, Ductile Iron Pipe, Centrifugally Cast, Gas

.2 B1.20.1, Pipe Threads, General Purpose (Inch)

.3 B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

.4 B16.3, Malleable Iron Threaded Fittings

.5 B16.5, Pipe Flanges and Flanged Fittings

.6 B16.9, Factory-Made Wrought Steel Butt-welding Fittings

.7 B16.11, Forged Fittings, Socket-Welding and Threaded

.8 B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250

.9 B16.21, Nonmetallic Flat Gaskets for Pipe Flanges

.10 B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

.11 B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Class 150, 300, 400, 600, 900, 1500 and 2500

.12 B16.25, Butt Welding Ends

.13 B16.42, Ductile Iron Pipe Flanges and Flanged Fittings, Classes 150 and 300

.2 ASME:

.1 Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels

.2 Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators

.3 B31.1, Power Piping

.4 B31.3, Process Piping

.5 B31.9, Building Services Piping

.6 B36.10M, Welded and Seamless Wrought Steel Pipe

.3 American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.

.4 ASTM:

.1 A47, Standard Specification for Ferritic Malleable Iron Castings

.2 A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.3 A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications

.4 A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

.5 A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

.6 A135, Standard Specification for Electric-Resistance-Welded Steel Pipe

.7 A139, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

.8 A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

.9 A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping

.10 A182/A182M, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service

.11 A183, Standard Specification for Carbon Steel Track Bolts and Nuts

.12 A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service

.13 A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or Both

.14 A197/A197M, Standard Specification for Cupola Malleable Iron

.15 A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

.16 A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

.17 A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels

.18 A276, Standard Specification for Stainless Steel Bars and Shapes

.19 A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates

.20 A285/A285M, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate Tensile Strength

.21 A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

.22 A312/A312M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes

.23 A320/A320M, Standard Specification for Alloy/Steel Bolting Materials for Low-Temperature Service

.24 A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems

.25 A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

.26 A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings

.27 A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service

.28 A536, Standard Specification for Ductile Iron Castings

.29 A563, Standard Specification for Carbon and Alloy Steel Nuts

.30 A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry

.31 A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures

.32 A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

.33 B32, Standard Specification for Solder Metal

.34 B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes

.35 B61, Standard Specification for Steam or Valve Bronze Castings

.36 B62, Standard Specification for Composition Bronze or Ounce Metal Castings

.37 B75, Standard Specification for Seamless Copper Tube

.38 B88, Standard Specification for Seamless Copper Water Tube

.39 B98/B98M, Standard Specification for Copper-Silicone Alloy Rod, Bar and Shapes

.40 C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment

.41 D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers - Tension

.42 D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate

.43 D1248, Standard Specification for Polyethylene (PE) Plastics Extrusion Materials for Wire and Cable

.44 D1330, Standard Specification for Rubber Sheet Gaskets

.45 D1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds

.46 D1785, Standard Specification for PVC Plastic Pipe, Schedules 40, 80, and 120

.47 D2000, Standard Classification System for Rubber Products in Automotive Applications

.48 D2310, Standard Classification for Machine-Made "Fibreglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

.49 D2464, Standard Specification for Threaded PVC Plastic Pipe Fittings, Schedule 80

.50 D2466, Standard Specification for PVC Plastic Pipe Fittings, Schedule 40

.51 D2467, Standard Specification for PVC Plastic Pipe Fittings, Schedule 80

.52 D2564, Standard Specification for Solvent Cements for PVC Plastic Piping Systems

.53 D2996, Standard Specification for Filament-Wound "Fibreglass" (Glass-Fibre-Reinforced Thermosetting-Resin) Pipe

.54 D3222, Standard Specification for Unmodified Polyvinylidene Fluoride (PVDF) Molding Extrusion and Coating Materials

.55 D3261, Standard Specification for Butt Heat Fusion PE Plastic Fittings for PE Plastic Pipe and Tubing

.56 D3350, Standard Specification for PE Plastics Pipe and Fittings Materials

.57 D4101, Standard Specification for Propylene Plastic Injection and Extrusion Materials

.58 F714, Standard Specification for PE Plastic Pipe (SDR-PR) Based on Outside Diameter

.5 AWWA:

.1 C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water

.2 C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 Inches Through 48 Inches for Water and Other Liquids

.3 C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings

.4 C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges

.5 C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water

.6 C153/A21.53, Ductile-Iron Compact Fittings 3 Inches through 24 Inches and 54 Inches through 64 Inches, for Water Service

.7 C200, Steel Water Pipe - 6 Inches and Larger

.8 C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inches and Larger - Shop Applied

.9 C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 Inches through 144 Inches

.10 C208, Dimensions for Fabricated Steel Water Pipe Fittings

.11 C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines

.12 C213, Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

.13 C214, Tape Coating Systems for the Exterior of Steel Water Pipelines

.14 C217, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried/Submerged Steel Water Pipelines

.15 C606, Grooved and Shouldered Type Joints

.16 M11, Steel Pipe - A Guide for Design and Installation

.6 American Welding Society (AWS):

.1 A5.8, Specification for Filler Metals for Brazing and Braze Welding

.2 QC 1, Standard for AWS Certification of Welding Inspectors

.7 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP43, Wrought Stainless Steel Butt-Welding Fittings Including Reference to Other Corrosion Resistant Materials

.8 National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances

.9 NSF:

.1 60, Drinking Water Treatment Chemicals - Health Effects.

.2 61, Drinking Water System Components - Health Effects.

1.3 Design Requirements

.1 Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

.1 Boiler and Steam Piping: ASME B31.1

.2 Process Piping: ASME B31.3

.3 Building Service Piping: ASME B31.9, as applicable

.4 Natural Gas Piping: CSA B149.1, Natural Gas and Propane Installation Code

.5 Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO Standard Specifications for Highway Bridges, as applicable

.6 Provincial Regulations

1.4 Submittals

.1 General:

.1 Provide process piping submittals separated in process areas as per drawing key plan:

.1 F: Filtration area

.2 R: Residuals area

.3 O: Ozone area

.4 C: Chemical area

.5 P: DAF area

.6 A: Administration area

.7 M: Main electrical area

.8 I: Raw water pump station area

.9 Y: Yard piping chambers area

.2 Identify process area in the title of all submittal transmittals.

.2 Shop Drawings:

.1 Shop Fabricated Piping:

.1 For epoxy coated steel piping, all sizes, and stainless steel piping, sizes 50 mm and larger, provide detailed pipe fabrication or spool drawings showing fittings and bends, dimensions, field weld locations, coatings, hydrotest information and other pertinent information.

.2 For shop fabricated piping that connects to existing flanges and nozzles, measure and show on the shop drawings the as-built information for the existing flange

centrelines, flange faces and any angular misalignment. Adjust design of new piping accordingly so that new piping accurately mates with existing piping.

.3 For embedded piping 100 mm and larger, provide layout drawings showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

.2 Hydraulic Thrust Restraint for Restrained Joints: details including materials, sizes, assembly ratings, and pipe attachment methods.

.3 Dissimilar Buried Pipe Joints: joint types and assembly drawings.

.3 Quality Control Submittals:

.1 Certificate of Satisfactory Installation, Form 102, as per Section 01650 - Equipment Installation.

.2 Laboratory Testing Equipment: certified calibrations, Manufacturer's product data, and test procedures

.3 Certified welding inspection and test results

.4 Qualifications:

.1 Weld Inspection and Testing Agency: Certification and qualifications

.2 Welding Inspector: certification and qualifications

.3 Welders:

.1 List of qualified welders and welding operators

.2 Current test records for qualified welder(s) and weld type(s) for factory and field welding

.5 Weld Procedures: records in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s)

.6 Nondestructive inspection and testing procedures

.7 Manufacturer's Certification of Compliance:

.1 Pipe and fittings.

.2 Welding electrodes and filler materials.

.3 Factory applied resins and coatings.

.8 Certified weld inspection and test reports

.9 Test logs

.10 Procedures pickling and passivation of stainless steel piping

.11 Pipe coating applicator certification

.12 Bacteriological testing report

1.5 Qualifications

.1 Independent Inspection and Testing Agency:

.1 Ten (10) years' experience in field of welding and welded pipe and fittings' testing required for this Work.

.2 Calibrated instruments and equipment, and documented standard procedures for performing specified testing.

.3 Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Work.

.4 Testing Personnel: qualified for non-destructive test methods to be performed.

.5 Inspection Services: qualified welding inspector.

.2 Welding Inspector: AWS certified, AWS QC 1 qualified, with prior inspection experience of welds specified.

.3 Welder and Welding Operator Qualifications:

.1 Qualified by accepted inspection and testing agency before starting Work in accordance with Section IX, Article III of the ASME Boiler and Pressure Vessel Code.

.2 Qualified to perform groove welds in Positions 2G and 5G for each welding process and pipe material specified.

.3 Qualification tests may be waived by the Contract Administrator based on evidence of prior qualification.

1.6 Quality Control

.1 Quality Control: Contractor shall provide services of independent inspection and testing agency for welding operations as approved by Contract Administrator.

.2 Welding materials, fabrication standards and labour qualifications shall conform to ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI B16.25, ASME Boiler and Pressure Vessel Code, Section 9, CSA W59 and the Provincial Board of Labour Regulations.

.3 Use welders fully qualified and licensed by provincial authorities in accordance with CSA W59.

1.7 Delivery, Storage, and Handling

.1 General:

.1 Flanges: securely attach metal, hardboard, or wood protectors over entire gasket surface.

.2 Threaded or Socket Welding Ends: fit with metal, wood, or plastic plugs or caps.

.3 Linings and Coatings: prevent excessive drying.

.4 Cold Weather Storage: locate Products to prevent coating from freezing to ground.

.5 Handling: use heavy canvas or nylon slings to lift pipe and fittings.

2. PRODUCTS

2.1 Piping

.1 As specified on Piping Data Sheets and Piping Schedule located at the end of this Section as Supplement.

.2 Diameters Shown:

.1 Standardized Products: nominal size.

.2 Fabricated Steel Piping (Except Cement-Lined): outside diameter, ASME B36.10M.

.3 Cement-Lined Steel Pipe: lining inside diameter.

2.2 Joints

.1 Grooved End System:

.1 Rigid, except where joints are used to correct misalignment, to provide flexibility, or where shown, furnish flexible type.

.2 Flanges: when required, furnish with grooved type flange adapters of same Manufacturer as grooved end couplings.

.2 Flanged Joints:

.1 Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.

.2 Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

.3 Threaded Joints: NPT taper pipe threads in accordance with ANSI B1.20.1.

.4 Mechanical Pipe Couplings: Provide Depend-O-Lok pipe couplings where shown on drawings.

.5 Thrust Tie-Rod Assemblies: NFPA 24; tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

.6 Mechanical Joint Anchor Gland Follower:

.1 Ductile iron anchor type, wedge action, with break off tightening bolts.

.2 Manufacturer and Product: EBAA Iron Inc.; Megalug.

.7 Flexible Mechanical Compression Joint Coupling:

.1 Stainless steel, ASTM A276, Type 305 bands.

.2 Manufacturers:

.1 Pipeline Products Corp.

.2 Fernco Joint Sealer Co.

.8 Mechanical connections of high density PE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through flanged connections consisting of the following:

.1 A PE stub end thermally butt-fused to end of pipe.

.2 ASTM A240, Type 304 stainless steel backing flange, 863 kPag, ANSI B16.1 standard. Insulating flanges shall be used where shown.

.3 Bolts and nuts of sufficient length to show a minimum of three (3) complete threads when the joint is made and tightened to Manufacturer's standard. Retorque nuts after four (4) hours.

.4 Gaskets as specified on Data Sheet.

2.3 Welding

.1 Welding materials shall be in accordance with CSA W48.

2.4 Gasket Lubricant

.1 Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.5 Fabrication

.1 Mark each pipe length on outside:

.1 Size or diameter and class

.2 Manufacturer's identification and pipe serial number

.3 Location number on laying drawing

.4 Date of manufacture

.2 Code markings according to approved Shop Drawings.

.3 Flanged pipe shall be fabricated in the shop, not in the field, and delivered to the Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by the Manufacturer.

2.6 Finishes

.1 Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s), Section 09870 - Coating Systems for Steel Tanks and Pipes, Section 15010 - General Mechanical Provisions, and Section 09901 – Painting and Finishing – Process Mechanical.

.2 Galvanizing:

.1 Hot-dip applied, meeting requirements of ASTM A153.

.2 Electroplated zinc or cadmium plating is unacceptable.

.3 Yellow Jacket

.1 High density polyethylene (HDPE) jacket extruded over a mastic base.

.2 Manufacture, test, inspect and report procedures to meet or exceed CAN3-Z299.3 (Quality Assurance Program - Category 3).

.3 Prior to mastic application, sandblast pipe in conformance with requirements or SSPC SP6.

.4 Adhesive consists of a rubberized asphalt mastic, non-hygroscopic, formulated for use with Yellow Jacket. Apply to prepared surfaces in thickness exceeding 0.175 mm.

.5 HDPE has the following minimum properties: Ultimate tensile strength, 21 MPa; Tensile elongation at break, 600%; Shore "D" hardness, 60; and Brittleness temperature -50°C.

.6 Apply HDPE by extruding over adhesive in an even thickness to provide a smooth continuous outer sheath, free of pinholes, bubbles, wrinkles, blisters, cracks, or mechanical damage.

.7 Minimum HDPE thickness will be as follows:

Nominal Pipe Diameter (mm)	Minimum HDPE Thickness (mm)
20	0.55
25	0.55
30	0.60
40	0.65
50	0.70
65	0.70
75	0.70
100	0.75
150	0.90
200 and larger	1.00

.8 All flaws (up to 3 per pipe) will be repaired by cutting out each damaged area and applying sealant lined 200 mm diameter patch or heat shrink sleeve not exceeding 400 mm in length. Overlap undamaged area by a minimum of 75 mm around cut out section.

.9 Where the number of flaws or damaged areas per pipe exceeds 3 or any flaw is too large to be repaired with a patch or sleeve, the pipe will be rejected.

.10 Tape Wrap: Shop applied tape wrap may be used as an alternative to Yellow Jacket. Two or three layer methods can be used, meeting or exceeding the application and performance requirements of AWWA C214.

3. EXECUTION

3.1 Piping Material Selection

.1 Select piping material for the various services based on Section 15200-00S – Piping Schedule.

3.2 Examination

.1 Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

.2 When connecting to existing flanges and nozzles, accurately measure pipe/flange locations and any angular misalignment and make appropriate adjustments so that new piping will mate up properly.

.3 Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

.4 Welding Electrodes: verify proper grade and type, free of moisture and dampness, and coating is undamaged.

3.3 Preparation

.1 Notify Contract Administrator at least two (2) weeks prior to field fabrication of pipe or fittings.

.2 Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

.3 Damaged Coatings and Linings: repair using original coating and lining materials in accordance with Manufacturer's instructions.

3.4 Welding

.1 Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.1, B31.3 and B31.9 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting Manufacturer

.2 Weld Identification: mark each weld with symbol identifying welder

.3 Pipe End Preparation:

.1 Machine Shaping: preferred

.2 Oxygen or Arc Cutting: smooth to touch, true, and slag removal by chipping or grinding

.3 Beveled Ends for Butt Welding: ANSI B16.25

.4 Surfaces:

.1 Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.

.2 Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.

.3 Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

.5 Alignment and Spacing:

.1 Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.

.2 Root Opening of Joint: as stated in qualified welding procedure.

.3 Minimum Spacing of Circumferential Butt Welds: minimum four times pipe wall thickness or 25mm, whichever is greater.

.6 Climatic Conditions:

.1 Do not perform welding if there is impingement of any rain, snow, sleet, or high wind on the weld area, or if the ambient temperature is below 0°C.

.2 Stainless Steel and Alloy Piping: If the ambient is less than 0°C, local preheating to a temperature warm to the hand is required.

.7 Tack Welds: performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

.8 Surface Defects: chip or grind out those affecting soundness of weld.

.9 Weld Passes: as required in welding procedure.

.10 Weld Quality: free of cracks, incomplete penetration, weld undercutting, excessive weld reinforcement, porosity slag inclusions, and other defects in excess of limits shown in applicable piping code.

3.5 Installation-General

.1 Join pipe and fittings in accordance with Manufacturer's instructions, unless otherwise shown or specified.

.2 Remove foreign objects prior to assembly and installation.

.3 Flanged Joints:

.1 Install perpendicular to pipe centreline.

.2 Bolt Holes: straddle vertical centrelines, aligned with connecting equipment flanges or as shown.

.3 Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.

.4 Plastic Flanges: install annular ring filler gasket at joints of raised-face flange.

.5 Raised-Face Flanges: use flat-face flange when joining with flat-faced ductile or cast iron flange.

.6 Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.

.7 Threaded flanged joints must be shop fabricated and delivered to Site with flanges in-place and properly faced.

.8 Manufacturer:

.1 Same as pipe Manufacturer.

.2 Victaulic flange adapter.

.4 Threaded and Coupled Joints:

.1 Conform to ANSI B1.20.1.

.2 Produce sufficient thread length to ensure full engagement when screwed home in fittings.

.3 Countersink pipe ends, ream and clean chips and burrs after threading.

.4 Make connections with not more than three threads exposed.

.5 Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

.5 Grooved-End Joints:

.1 Type: rigid, except where joints are used to correct misalignment, to provide flexibility, and where shown otherwise, in which case provide flexible type.

.6 Soldered Joints:

.1 Use only solder specified for particular service.

.2 Cut pipe ends square and remove fins and burrs.

.3 After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.

.4 Wipe excess solder from exterior of joint before hardened.

.5 Before soldering, remove stems and washers from solder joint valves.

.7 PVC and CPVC Piping:

.1 Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.

.2 Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.

.3 Do not thread Schedule 40 pipe.

.8 Fibreglass Reinforced Piping:

.1 Cut, fabricate, and install in accordance with Manufacturer's written instructions.

.2 Provide Manufacturer's representative for instructing workers on proper installation and jointing methods.

.3 Installation shall be made by workers experienced in FRP pipe lay-up techniques.

.9 All bolt threads shall be coated with an anti-seize compound prior to being made up with nuts unless otherwise specified in the detail piping system specifications. All bolts for submerged flanges shall be coated with an anti-seize compound that has NSF-61 certification.

3.6 Pipe Coatings

.1 Provide epoxy coating and lining on piping when indicated on the piping data sheet(s) or in Section 15200-00S – Piping Schedule.

.2 Shop apply coating and lining to the greatest extent possible. Touch up coating and linings in the field as required. Minimize the number of field welds and use only where shown on approved shop drawings. Apply coating and lining to field welds and meet the same surface preparation, coating and testing requirements as shop welds.

.3 Before applying coatings and linings to metal piping, grind and round off all sharp edges, maximum radius of edges: 6mm.

.4 All interior epoxy coatings shall conform to NSF Standard 61 – Drinking Water System Components, suitable for use in potable water applications. Coating materials and application shall be in accordance with Section 09870 - Coating Systems for Steel Tanks and Pipes.

.5 Colour of top coat: As selected by Contract Administrator from a set of standard colours which shall include white.

3.7 Tape Wrap

.1 For welded joints on Yellow jacketed pipe and at other indicated locations apply tape to buried pipe and fittings. Use Polyken, Tec-Tape or Denso tape, consisting of primer and tape applied to minimum thickness of 0.90 mm in accordance with AWWA C209.

.2 For flanged or coupled joints and for fittings use petrolatum primer, mastic and tape; Polyken, Tec-Wrap or Denso, in accordance with AWWA C217.

.3 Shrink Sleeve: As an alternative to tape wrap, shrink sleeves are acceptable if material and method of installation is reviewed and accepted by the Contract Administrator prior to use.

3.8 Installation-Exposed Piping

.1 Piping Runs:

.1 Parallel to building or column lines and perpendicular to floor, unless shown otherwise.

.2 Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

.2 Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

.3 Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

.4 Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other Work.

.5 Piping clearance, unless otherwise shown:

.1 Over Walkway and Stairs: minimum of 2200 mm, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.2 Between Equipment or Equipment Piping and Adjacent Piping: Minimum 1000 mm, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.3 From Adjacent Work: minimum 100 mm from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.

.4 Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.

.5 Headroom in front of openings, doors, and windows shall not be less than the top of the opening.

.6 Do not install piping containing liquids or liquid vapours in transformer vaults or electrical equipment rooms.

.7 Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical Work.

3.9 Installation-Buried Pipe

.1 Joints:

.1 Dissimilar Buried Pipes: Supply and install flexible mechanical compression joints for pressure pipe.

.2 Concrete Encased or Embedded Pipe: do not encase joints in concrete unless specifically shown.

.2 Placement:

.1 Keep trench dry until pipe laying and joining are completed.

.2 Pipe base material will be placed by Others.

.3 Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.

.4 Measure for grade at pipe invert, not at top of pipe.

.5 Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.

.6 Prevent foreign material from entering pipe during placement.

.7 Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's Work.

.8 Lay pipe upgrade with bell ends pointing in direction of laying.

.9 Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, supply and install:

.1 Shorter pipe lengths.

.2 Special mitered joints.

.3 Standard or special fabricated bends.

.10 After joint has been made, check pipe alignment and grade.

.11 Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

.12 Prevent uplift and floating of pipe prior to backfilling.

.3 PVC, CPVC, or HDPE Pipe Placement:

.1 Lay pipe snaking from one side of trench to other.

.2 Offset: As recommended by Manufacturer for maximum temperature variation between time of solvent welding and during operation.

.3 Do not lay pipe when temperature is below 5°C, or above 32°C when exposed to direct sunlight.

.4 Shield ends to be joined from direct sunlight prior to and during the laying operation.

.4 Tolerances:

.1 Deflection from Horizontal Line, Except PVC, CPVC, or HDPE**:** maximum 2 mm**.**

.2 Deflection From Vertical Grade: maximum 6 mm.

.3 Joint Deflection: maximum of 75% of Manufacturer's recommendation.

.4 Horizontal position of pipe centreline on alignment around curves maximum variation of 500 mm from position shown.

.5 Pipe Cover: minimum 2700 mm, unless otherwise shown.

3.10 Installation – Concrete Encased

.1 Supply and install reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs and other structures shall be concrete encased. See details on Drawings for encasement requirements.

.2 Where concrete encased piping crosses structure construction and expansion joints, supply and install flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.11 Thrust Restraint

.1 Location:

.1 Buried Piping: where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist due to hydrostatic testing and normal operating pressure.

.2 Exposed Piping: at all joints in piping.

.2 Thrust Ties:

.1 Steel Pipe: attach with fabricated lugs.

.2 Ductile Iron Pipe: attach with socket clamps against a grooved joint coupling or flange.

.3 Flanged Coupling Adapters: for exposed installations, install Manufacturer's anchor studs through the coupling sleeve.

.3 Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: install pipe joint Manufacturer's adapter gland follower and pipe end retainer, or thrust tie-rods and socket clamps.

3.12 Pipe Sleeves

.1 Refer to Section 15010 – General Mechanical Provisions.

3.13 Wall Pipes for Slab, Floor, Wall, and Roof Penetrations

.1 Steel or Stainless Steel Wall Pipe:

.1 Same material and thickness as connecting pipe, except 6 mm minimum thickness.

.2 Lining: same as connecting pipe, factory-applied.

.3 Thrust Collar:

.1 Outside Diameter: unless otherwise shown, 75 mm greater than outside diameter of wall pipe.

.2 Continuously fillet welded on each side all around.

.2 Ductile Iron Wall Pipe:

.1 Diameter and Ends: same as connecting ductile iron pipe.

.2 Thickness: equal to or greater than remainder of pipe in line.

.3 Fittings: in accordance with applicable Pipe Data Sheet.

.4 Thrust Collars:

.1 Rated for thrust load developed at 250 psi.

.2 Safety Factor: 2, minimum.

.3 Material and Construction: ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.

.5 Manufacturers:

.1 American Cast Iron Pipe Co.

.2 U.S. Pipe and Foundry Co.

3.14 Branch Connections

.1 Do not install branch connections smaller than 13 mm nominal pipe size, including instrument connections, unless shown otherwise.

.2 When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including the first block valve in the line carrying the lower pressure, unless otherwise shown.

.3 Threaded Pipe Tap Connections:

.1 Ductile Iron Piping: connect only with service saddle or at a tapping boss of a fitting, valve body, or equipment casting.

.2 Welded Steel or Alloy Piping: connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.

.3 Limitations: threaded taps in pipe barrel are unacceptable.

3.15 Vents and Drains

.1 Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations; except for epoxy coated pipe, install vents and drains only where shown.

3.16 Interim Cleaning

.1 Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

.2 Examine piping to assure removal of foreign objects prior to assembly.

.3 Shop cleaning may employ conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.17 Testing

.1 General:

.1 Conduct hydraulic pressure and leakage tests on newly installed piping.

.2 Supply and install necessary equipment and material and make taps in pipe, as required. Provide blind flanges as required.

.3 Contract Administrator will monitor the tests. Provide advance notice of start of testing.

.4 Test Pressures: As specified.

.5 Test Records: make records of each piping system installation during the test to document the following:

.1 Date of test

.2 Description and identification of piping tested

.3 Test fluid

.4 Test pressure

.5 Remarks, including:

.1 Leaks (type, location)

.2 Repairs made on leaks

.6 Certification by Contractor and signed acknowledgment by Contract Administrator that tests have been satisfactorily completed.

.2 Testing New Pipe Connected to Existing Pipe: isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.

.3 Concrete Encased Piping: Test piping prior to placement of concrete.

.4 Preparation and Execution:

.1 Buried Pressure Piping:

.1 Conduct final hydrostatic acceptance tests after trench has been completely backfilled.

.2 An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by the Contract Adminisstrator.

.3 Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.

.2 Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

.5 Hydrostatic Leak Tests:

.1 Equipment: Supply and install the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

.2 Procedure:

.1 Use water as the hydrostatic test fluid.

.2 Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.

.3 Open vents at high points of the piping system to purge air pockets while the piping system is filling.

.4 Venting during the filling of the system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.

.5 Test piping systems at the test pressure specified in Section 15200-00S - Piping Schedule.

.6 Maintain hydrostatic test pressure continuously for thirty (30) minutes minimum and for such additional time as necessary to conduct examinations for leakage.

.7 Examine joints and connections for leakage.

.8 The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.

.9 Correct visible leakage and retest to satisfaction of the Contract Administrator.

.3 Gravity Sewers and Drains:

.1 Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.

.2 Repair leaks and retest system until no further leakage is evident.

.6 Pneumatic Leak Tests:

.1 Perform on compressed air, instrument air, natural gas, and vacuum piping.

.2 Equipment: Supply and install the following:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105% of the required primary test pressure
1	Calibrated test gauge

.3 Procedure:

.1 Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.

.2 Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.

.3 Test piping system at the test pressure specified in the Piping Schedule.

.4 Take necessary precautions to protect personnel from hazards associated with air testing.

.5 Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.

.6 Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.

.7 Apply maximum 172 kPa preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.

.8 Examine joints and connections for leakage with soap bubbles.

.9 Correct visible leaks and retest to satisfaction of the Contract Administrator.

.10 Gradually increase pressure in the system to not more than one-half of test pressure.

.11 Thereafter increase pressure in steps of approximately one tenth ($^1/_{10}$) of maximum test pressure until required test pressure is reached.

.12 Maintain pneumatic test pressure continuously for minimum ten (10) minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.

.13 The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.

.14 Correct visible leakage retest to satisfaction of the Contract Administrator.

.15 Following pneumatic testing, thoroughly purge, with nitrogen, lines that are to carry flammable gases to assure no explosive mixtures will be present in the system during the filling process.

3.18 Cleaning and Disinfection

.1 Following assembly and testing, and prior to final acceptance, flush piping with water, (except as stated below), and remove accumulated construction debris and other foreign matter.

.2 Insert cone strainers in the connections to attached equipment and leave until cleaning has been accomplished.

.3 Minimum Flushing Velocity: 0.8 m per second.

.4 Blow clean of loose debris plant process air, natural gas, and instrument air-lines with compressed air; do not flush with water.

.5 Remove accumulated debris through drains 50 mm and larger or by removing spools and valves from piping.

.6 Immediately following drainage of flushed lines, dry piping with compressed air.

.7 Plant process air and compressed air piping shall be blown clean of loose debris with compressed air.

.8 Clean all oxygen and ozone piping, including vents and drains, in accordance with Compressed Gas Association Pamphlet 4.1.

.9 Disinfect piping intended to carry potable water before placing in service:

.1 Meet the requirements of AWWA C651, unless otherwise specified.

.2 Disinfecting Mixture:

.1 A chlorine-water solution having a free chlorine residual of 40 mg/L to 50 mg/L.

.2 Prepare by injecting one of the following:

.1 Liquid chlorine gas-water mixture.

.2 Calcium or sodium hypochlorite and water mixture.

.3 Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution is of the specified strength.

.4 Apply liquid chlorine -water mixture by means of a chlorinating device.

.5 Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 mg/L chlorine).

.6 Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1 percent solution.

.7 The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite [1] (65 - 70 percent C1)	0.5 kg	28.5 Litres
Sodium Hypochlorite [2] (5.25 percent C1)	3.8 Litres	16 Litres
1. Comparable to commercial products known as HTH, Perchloron, and Pittchlor. 2. Known as liquid laundry bleach, Clorox, and Purex.		

.10 Point of Application:

.1 Inject chlorine mixture into piping to be treated at the beginning of the line through a suitable tap in the piping.

.2 Control clean water from the existing system or another source so it flows slowly into newly installed piping during chlorine application.

.3 Manipulate valves so the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.

.11 Retention Period:

.1 Retain treated water in pipeline for a minimum of 24 hours or long enough to destroy nonspore-forming bacteria.

.2 At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 mg/L of chlorine.

.3 Operate valves, hydrants, and other appurtenances during disinfection to assure disinfecting mixture is dispersed into all parts of the pipeline including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.

.4 Do not place concentrated quantities of commercial disinfectants in pipeline before filling with water.

.5 After chlorination, flush the water from the permanent source of supply until water through pipeline is equal chemically and bacteriologically to the permanent source of supply.

.6 Sample water and have bacteriological testing performed by an approved lab. Submit a report to the Contract Administrator.

.12 Disposal of Disinfecting Water:

.1 Dispose of disinfecting water in an acceptable manner that will protect the public and receiving waters from harmful or toxic concentrations of chlorine.

.2 Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level. Dechlorination may be required.

3.19 Pickling and Passivation

.1 All stainless steel piping shall be cleaned and passivated in accordance with ASTM A380.

.2 Peroxide piping shall be cleaned and passivated in accordance with the Hydrogen Peroxide supplier's procedures (Brenntag Canada Inc.). Confirm procedures with Contract Administrator before proceeding.

3.20 Field Finishing

.1 Notify Contract Administrator at least three (3) days prior to start of any surface preparation or coating application work.

.2 As specified in Section 09870 - Coating Systems for Steel Tanks and Pipes.

.3 Paint the exterior of ferrous metal piping, copper piping, iron piping and PVC piping in accordance with Section 09901 – Painting and Finishing – Process Mechanical**.**

.4 Repair any damage to coating and lining on embedded pipes and sleeves.

3.21 Pipe Identification

.1 Refer to Section 15010 – General Mechanical Provisions.

3.22 Field Quality Control

.1 Pressure test piping for leakage. Refer to Section 15200-00S - Piping Schedule for test pressures and test media.

.2 Minimum Duties of Welding Inspector:

.1 Job material verification and storage.

.2 Qualification of welders.

.3 Certify conformance with approved welding procedures.

.4 Maintenance of records and preparation of reports in a timely manner.

.5 Notification to Contract Administrator of unsatisfactory weld performance within twenty four (24) hours of weld test failure.

.3 Required Weld Examinations:

.1 Perform examinations in accordance with Piping Code**:** ASME B31.3. 10% of the circumferential butt welds shall be random radiographed. For concrete encased steel pipes and pipes under foundations, provide radiographic examination of 50% of welds as selected by the Contract Administrator.

.2 Perform examinations for every pipe thickness and for each welding procedure, progressively, for all piping covered by this section.

.3 Examine at least one (1) of each type and position of weld made by each welder or welding operator.

.4 For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two (2) additional welds for each tracer examination found to be unsatisfactory.

3.23 Supplements

.1 Piping Schedule – 15200-00S.

.2 Data Sheets.

Number	Title
15200-03	Carbon Steel Pipe and Fittings-General Service
15200-04	Carbon Steel Pipe and Fittings-Large Diameter
15200-07	Galvanized Steel Pipe and Fittings – General Service
15200-08	Stainless Steel Pipe and Fittings-General Service
15200-09	Stainless Steel Pipe and Fittings-Special Service 1
15200-10	Polyvinyl Chloride (PVC) Pipe and Fittings
15200-12	Fibreglass Reinforced Plastic (FRP) Pipe and Fittings
15200-13	Copper and Copper Alloy Pipe, Tubing, and Fittings
15200-14	High Density Polyethylene (HDPE) Pipe
15200-19	Stainless Steel Pipe and Fittings-Special Service No. 2
15200-20	Stainless Steel Pipe and Fittings-Special Service No. 3
15200-21	Carbon Steel Pipe and Fittings-Natural Gas Service

END OF SECTION

PIPING SERVICE LEGEND

SERVICE	
AA	Aqua Ammonia
AGA	Atomizing Air
AHP	Air-High Pressure
ALP	Air-Low Pressure
AS	Air Scour
AV	Acid Vent
AW	Acid Waste
BBD	Boiler Blowdown
BS	Brine Solution
BWS	Backwash Supply
BWW	Backwash Wastewater
CA	Compressed Air
CCW	Circulating Cooling Water
CDR	Condenser Water Return
CDS	Condenser Water Supply
CGR	Condenser Glycol Return
CGS	Condenser Glycol Supply
CHR	Chilled Water Return
CHS	Chilled Water Supply
CL2	Chlorine
CLG	Chlorine Gas
CLS	Chlorine Solution
CO2	Carbon Dioxide
CRW	Clarified Discharge Water
CS	Caustic (Sodium Hydroxide)
CWR	Cooling Water Return
CWS	Cooling Water Supply
DD	Deacon Effluent (Post UV)
DDW	Demineralized Water

PIPING SERVICE LEGEND

DEA	Dilute Acid
DEC	Dilute Caustic
DF	DAF Float
DFR	Diesel Fuel Return
DFS	Diesel Fuel Supply
DHW	Domestic Hot Water
DO	Dissolved Oxygen
DRA	Drainage (Floors)
DRN	Drains (Clean Drains)
DRS	Subdrain
DS	Deacon Suction
DSW	Distilled Water
DU	Deacon UV (Pre UV)
EE	Engine Exhaust
ELC	Electrical Conduit
ER	Effluent Return
ES	Effluent Supply
EXP	Expansion Tank Equalizer Line
FC	Ferric Chloride
FED	Filter Media Eduction
FIN	Filter Influent
FIR	Firewater
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
FOV	Fuel Oil Vent
FPW	Fire Protection Water
FTR	Filter To Recycle
FW	Filtered Water
GHR	Glycol Heating Return
GHS	Glycol Heating Supply

PIPING SERVICE LEGEND

GOX	Gaseous Oxygen
HCO	Hydraulic Oil
HFS	Hydrofluosilicic Acid
HP	Hydrogen Peroxide
HPS	High Pressure Steam
HR	High Pressure Condensate
HST	12% Hypochlorite Solution
HYP	0.8% Hypochlorite Solution
LGO	Lubricating Oil
LOX	Liquid Oxygen
LPC	Low Pressure Condensate
LPS	Low Pressure Steam
LT	Level Transmitter Sleeve Embed
MPC	Medium Pressure Condensate
MPS	Medium Pressure Steam
MU	Make-Up Water
NG	Natural Gas
OF	Overflow
OZG	Ozone Off Gas
OZO	Ozonated Oxygen
OZW	Ozonated Water
P	Propane
PC	Pumped Condensate
PEF	Phosphate Feed
PLD	Dry Polymer
PLS	Polymer Solution
PSW	Plant Service Water
PW	Potable Water
RD	Roof Drain
RS	Refrigerant Suction

PIPING SERVICE LEGEND

RW	Raw Water
RWL	Raw Water Leader
SAM	Sample
SAN	Sanitary Drainage
SBS	Sodium Bisulphite
SCA	Sulphuric Acid
SDR	Saturated Recycle Water
SHC	Sodium Hypochlorite
SLO	Seal Oil
SLU	Sludge
SP	Sprinkler Pipe
ST	Storm
STD	Salt Dry
SUP	Supernatant
SW	Seal Water
SWD	Stormwater Drainage
TDW	Tempered Domestic Water
TP	Trap Primer
TRW	Treated Water
TW	Tempered Water
VAC	Vacuum
VTA	Vent Air
WS	Softened Water

EXPOSURE

BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

PIPING SERVICE LEGEND

MATERIAL

CI	Cast Iron
CLDI	Cement-Lined Ductile Iron
CMP	Corrugated Metal Pipe
COP	Copper
CPVC	Chlorinated PVC
CS	Carbon Steel
DI	Ductile Iron
FRP-X	Fiberglass Reinforced Plastic Pipe (X = 1 to 6)
GLDI	Glass-Lined Ductile Iron
GSP	Galvanized Steel Pipe
HDPE	High Density Polyethylene
PCCP	Prestressed Concrete Cylinder Pipe
PE	Polyethylene
PSTL	PVDF-Lined Steel
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
RCP	Reinforced Concrete Pipe
RSTL	Rubber-Lined Steel
SST	Stainless Steel
STL	Steel
VC	Vitrified Clay Pipe

PRESSURE TEST

H	Hydrostatic
I	In Service
P	Pneumatic
NA	Not Applicable

END OF SECTION

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
DAF AREA							
Compressed Air	CA	32	EXP	COP	15200-13	P, 1035	
Clarified Raw Water	CRW	150, 250, 400	EXP	SST	15200-09	H, 345	DAF Recycle lines
Clarified Raw Water	CRW	350	Embed	Epoxy coated/lined steel	15200-03	H, 100	DAF laterals
DAF Float	DF	75,100	EXP	FRP1	15200-12	H, 200	
DAF Float	DF	100, 300	Embed	FRP1	15200-12	H, 100	
DAF Float	DF	300	SUB	FRP1	15200-12	H, 100	
Process Waste Drainage	DRN	100	EXP	PVC	15200-10	H, 100	In DAF Pump Gallery
Process Waste Drainage	DRN	100	ENC	PVC	15200-10	H, 100	From mud valves to DAF Pump Gallery
Process Waste Drainage	DRN	100	Embed	Epoxy coated/lined steel	15200-03	H, 100	Transition through wall from under DAF tanks into DAF Pump Gallery
Ferric Chloride	FC	50	EXP	PVC	15200-10	H, 1050	
Raw Water	RW	300, 450, 600, 1050, 1200, 1350	EXP	Epoxy coated/lined steel	15200-03, 15200-04	H, 345	
Sample	SAM	25	EXP	PVC	15200-10	H, 100	Sample lines to analyzers
Sulfuric Acid	SCA	50	EXP	SST	15200-09	H, 1050	
Saturated Recycle Water	SDR	150, 250, 300, 450	EXP	SST	15200-09	H, 1500	Sections of the 150 and 250 are being supplied by Leopold (316 SS)
Process Sump Pump	DRN	100, 300, 400	EXP, Conc Encased	Epoxy coated/lined steel	15200-03	H, 100	
OZONE AREA							
Process Air - Low Pressure	ALP	6,12,25	EXP	SST	15200-09	P, 500	
Circulating Cooling Water	CCW	38, 65, 75	EXP	SST	15200-09	H, 800	
Closed Loop Cooling Water Return	CWR	19, 38, 75, 100	EXP	SST	15200-09	H, 800	
Closed Loop Cooling Water Supply	CWS	38, 75, 100	EXP	SST	15200-09	H, 800	
Ozone Contactor Process Drain	DRN	6, 12, 50, 200	EXP	SST	15200-09	H, 800	
Gaseous Oxygen	GOX	19, 50, 75, 100	EXP	SST	15200-09	P, 800	
Gaseous Oxygen	GOX	19, 50, 75, 100	BUR	SST	15200-09	P, 800	
Hydrogen Peroxide	HP	25	EXP	SST	15200-09	H, 800	
Liquid Oxygen	LOX	6, 12, 25, 50	EXP	COP	15200-13	P, 2500	
Ozone Gas	OZG	6, 50, 64, 75, 100	EXP	SST	15200-09	P, 850	
Ozone Gas	OZG	6, 50, 64, 75, 100	SUB	SST	15200-09	P, 1500	
Ozonated Oxygen	OZO	50, 75	EXP	SST	15200-09	P, 850	
Ozonated Water	OZW	19, 50, 38, 900	EXP	SST	15200-09	H, 800	
Polymer	PLS	25	EXP	PVC	15200-10	H, 800	
Plant Service Water	PSW	12, 50, 75	EXP	COP	15200-13	H, 800	
Sodium Bisulphite	SBS	25	EXP	SST	15200-10	H, 800	
Vent	VTA	19, 50, 100, 150, 200	EXP	SST	15200-09	P, 500	
FILTRATION AREA							

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
Ammonia	AA	50	EXP / SUB	SST	15200-09	H, 800	Test with piping / tanks
Air Scour Supply	AS	300	EXP / SUB	SST	15200-09	H, 350	Test with piping / tanks
Air Scour Supply	AS	350, 400	EXP	SST	15200-09	H, 350	Test with piping / tanks
Backwash Supply	BWS	600, 750, 900	EXP/ Concrete ENC / SUB	Epoxy coated/lined steel	15200-04	H, 350	Test prior to concrete encasement with blind flanges. Test connections with piping / tanks
Backwash Waste Water	BWW	900	SUB	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks
Cooling Water Supply	CWS	50, 65, 75, 100, 150	EXP	SST	15200-09	H, 350	Test with piping / tanks
Chilled Water Supply	CHS	50, 65, 75, 100, 150	EXP	SST	15200-09	H, 350	Test with piping / tanks
Sodium Hydroxide	CS	50	EXP / SUB	Epoxy coated steel	15200-03	H, 800	Test with piping / tanks
Drain for Process water	DRN	50, 75, 100, 150, 200	EXP / Concrete ENC	SST	15200-09	H, 170	Test with piping / tanks
Drain	DRN	12, 25	EXP	PE	15200-14	H, 170	Test with piping / tanks
Filter Media Eductor System	FED	100	EXP	SST	15200-09	H, 170	Test with piping / tanks. Provide epoxy coated/lined STEEL BLIND FLANGES (8) with SST bolts/nuts.
Filter Media Eductor System	FED	200	EXP	SST	15200-09	H, 170	Test with piping / tanks. Provide epoxy coated/lined STEEL BLIND FLANGES (12) with SST bolts/nuts.
Filter Influent	FIN	12, 25, 50,75,100	EXP	SST	15200-09	H, 170	Test with piping / tanks
Filter Influent	FIN	900	SUB	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks
Filter to Recycle	FTR	600, 750	EXP	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks
Filtered Water	FW	12	EXP	PE	15200-14	H, 170	For sampling lines as noted on Detail 1 and 2 WF-M0452 only.
Filtered Water	FW	12,25, 50,75	EXP	SST	15200-09	H, 170	Test with piping / tanks. Provide SST tubing as noted on Detail 1 and 2 WF-M0451.
Filtered Water	FW	100	EXP	SST	15200-09	H, 170	Test with piping / tanks. Provide epoxy coated/lined STEEL BLIND FLANGES (6) with SST bolts/nuts.
Filtered Water	FW	600, 900	EXP	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks
Filtered Water	FW	1350	Concrete ENC / EXP	Epoxy coated/lined steel	15200-04	H, 170	Test prior to concrete encasement with blind flanges. Test connections with piping / tanks
Filtered Water	FW	2100	BURIED / SUB	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks.
Sodium Hypochlorite	HYP	25, 50	EXP	PVC	15200-10	H, 800	Test with piping / tanks
Level Transmitter Sleeve	LT	100	EXP	PVC	15200-10	H, 170	Test with piping / tanks. For wall mounted LT-100 standpipes, use PVC pipe.
Level Transmitter Sleeve	LT	100	Concrete ENC	SST	15200-09	H, 170	Test with piping / tanks. Concrete encased or embeds.

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
Manway	MANWAY	900	EXP	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks.
Manway	MANWAY	1200	EXP	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks.
Overflow	OF	150, 200, 400	EXP	Epoxy coated/lined steel	15200-03	H, 170	Test with piping / tanks
Overflow	OF	600	EXP	Epoxy coated/lined steel	15200-04	H, 170	Test with piping / tanks
Overflow	OF	600	SUB	SST	15200-09	H, 170	Test with piping / tanks
Pressure Transmitter Tube/Sleeve	PT	12, 25, 50	EXP	SST	15200-09	H, 170	Test with piping / tanks
Sample	SAM	12	EXP	PE	15200-14	H, 170	Test with piping / tanks
Sample	SAM	25, 50	EXP	SST	15200-09	H, 170	Test with piping / tanks
Vent Air	VTA	12, 25, 50, 75, 100, 150, 200, 300	EXP	SST	15200-09	H, 170	Test with piping / tanks
RESIDUAL AREA							
DAF Float	DF	200	EXP	FRP1	15200-12	H,100	
Ozone Contactor Process Drain	DRN	150	EXP	SST	15200-09	H, 800	
Surge Relief Discharge	DRN	100	EXP	Epoxy coated/lined steel	15200-03	P,800	
Surge Relief Discharge	DRN	300	EXP	Epoxy coated liner	15200-03	H,800	
Pilot Plant Effluent	DRN	250	EXP	Epoxy coated/lined steel	15200-03	H,100	Complete pipe within the weir wall and 239.41 slab
Backwash Supply Tank Overflow	OF	600	SUB	SST	15200-09	H,170	Backwash tank O/F within the WRT area.
TSET Overflow	OF	200	SUB	Epoxy coated/lined steel	15200-03	H,200	
Flocculation Chamber	OF	200	SUB	Epoxy coated/lined steel	15200-03	H,200	Flocculated sludge chamber overflow to gravity thickener.
Polymer Feed Pipe	PLS	25	EXP	PVC	15200-10	H, 800	
Thickener Floc Tank Overflow	SLU	200	SUB/ EXP	Epoxy coated/lined steel	15200-03	H,100	One penetration is immersed other two could be exposed or immersed
Thickener Floc Tank Discharge	SLU	200	EXP	Epoxy coated/lined steel	15200-03	H,100	Flocculated sludge feed to gravity thickeners
Thickener Sludge Extraction	SLU	200	Concrete ENC	Epoxy coated/lined steel	15200-03	H,200	Concrete-encased. Refer to enc.

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
Thickened Sludge Individual Discharge	SLU	100	EXP	Epoxy coated/lined steel	15200-03	H,200	
Thickened Sludge Discharge Header	SLU	150	EXP/ Concrete ENC	Epoxy coated/lined steel	15200-03	H,200	Embed under DAF galery to 1m beyond electrical room slab.
TSET Intercell Isolation	SLU	300	SUB	Epoxy coated/lined steel	15200-03	H,200	TSET Tank1 and 2 wall
Washwater Recovery Tank (WRT) Sludge Extraction	SLU	200	EXP	Epoxy coated/lined steel	15200-03	H,100	WRT sludge discharge pipe to flocculation tank
Gravity Thickener Supernatant Discharge	SUP	200	EXP/ Concrete ENC	Epoxy coated/lined steel	15200-03	H,100	
Washwater Tank Supernatant (Decant)	SUP	750	SUB	Epoxy coated/lined steel	15200-04	H,800	Within WRTs' walls and supernatant pump station wall.
Supernatant Discharge Pipe	SUP	750	EXP/ Concrete ENC	Epoxy coated/lined steel	15200-04	H, 800	Embed under DAF gallery to 1m beyond electrical room slab.
CHEMICAL AREA							
Hydrogen Peroxide	HP	25, 50, 75, 100	Exposed	SST	15200-19	H, 600	
Hydrogen Peroxide - Vent	VTA	25, 150	Exposed	SST	15200-19	N/A	
Hydrogen Peroxide - Overflow	OF	100	Exposed	SST	15200-19	H, 600	
Sodium Bisulphite	SBS	25, 50, 75	Exposed	SST	15200-09	H, 800	
Sodium Bisulphite - Vent	VTA	25, 150	Exposed	SST	15200-09	N/A	
Sodium Bisulphite - Drain	DRN	75	Exposed	SST	15200-09	N/A	
Sodium Bisulphite - Overflow	OF	50	Exposed	SST	15200-09	N/A	
Dry Polymer	PLD	50	Exposed	SST	15200-20	P, 250	
Polymer	PLS	12, 25, 50, 75	Exposed	PVC	15200-10	H, 800	
Polymer - Vent	VTA	25, 100	Exposed	PVC	15200-10	N/A	
Polymer - Overflow	OF	75	Exposed	PVC	15200-10	N/A	
Polymer - Drain	DRN	75, 150	Exposed	PVC	15200-10	N/A	
Aqua Ammonia	AA	50	Exposed	SST	15200-09	H, 1050	
Sodium Hydroxide	CS	50	Exposed	Epoxy coated/lined steel	15200-03	H, 1050	
Ferric Chloride	FC	25	Exposed	PVC	15200-10	H, 1050	
Sulphuric Acid	SCA	25	Exposed	SST	15200-09	H, 1050	
Sodium Hypochlorite	SHC	25, 50	Exposed	PVC	15200-10	H, 600	
BUILDING SERVICES							
Compressed Air	CA	All	EXP	COP	15200-13	P, 1035	
Condenser Water Return	CDR	All	EXP	CS	15200-03	H, 620	
Condenser Water Return	CDR	75 and smaller	EXP	COP	15200-13	H, 1000	
Condenser Water Supply	CDS	All	EXP	CS	15200-03	H, 620	

Service	Commodity Abbreviation	Nominal Size(s) (mm)	Exposure[2]	Piping Material[2]	Specification Section	Test Type and Pressure (kPa)[1]	Remarks
Condenser Water Supply	CDS	75 and smaller	EXP	COP	15200-13	H, 1000	
Domestic Cold Water	DCW	75 and smaller	EXP/ BUR	COP	15200-13	H, 1000	
Sump Pump Discharge	DRA	All	EXP/ BUR	GSP	15200-07	H, 300	
Sanitary Drain	DRA	All	EXP/ ENC	CI	15100-02	N/A	Test per requirement of Plumbing Code
Heat Pump Water Return							
Heat Pump Water Supply							
Sump Pump Discharge	DRN	All	EXP/ BUR	Epoxy coated/lined steel	15200-03	H, 500	Sanitary lift station
Fire Water	FIR	All	EXP	Steel	15200-03	H, 1555	
Fire Water	FIR	All	BUR	Epoxy coated/lined steel	15200-03	H, 1555	
Natural Gas	NG	All	EXP	CS	15200-21	P, 100	All except ozone Generator Room
Natural Gas	NG	All	BUR	CS	15200-21	P, 100	see note 3
Natural Gas	NG	All	EXP	CS	15200-21	P, 100	Ozone Generator Room
Plant Service Water (non-potable)	PSW	75 and smaller	EXP	COP	15200-13	H, 1000	
Plant Service Water (non-potable)	PSW	100 and larger	EXP	Epoxy coated/lined steel	15200-03	H, 1345	
Potable Water	PW	150, 200	ENC	Epoxy coated/lined steel	15200-03	H, 1345	
Stormwater Drain	SWD	All	EXP	CI	15100-02	N/A	Test per requirement of Plumbing Code
Trap Primer	TP	All	EXP/ BUR	COP	15200-13	H, 1000	Test per requirement of Plumbing Code
Vent (Sanitary)	VTA	75 and smaller	EXP/ BUR	COP	15100-01	N/A	Test per requirement of Plumbing Code
Vent (Sanitary)	VTA	100 and larger	EXP/ BUR	CI	15100-02	N/A	Test per requirement of Plumbing Code
Raw Water Pumping Station							
Raw Water	RW	200, 900, 1350	Exposed	Epoxy Coated / Lined Steel	15200-03, 15200-04	H, 345	Raw water supply to the WTP.
Raw Water	RW	450	Exposed/buried	Epoxy Coated / Lined Steel	15200-03, 15200-04	H, 345	Raw water supply to Fire Pumping room.
Vent	VTA	300	Exposed	Sch.80 PVC	15200-10	N/A	Wetwell Vents
Air Release	VTA	25	Exposed	Epoxy Coated / Lined Steel	15200-03	H, 345	Air release from large diameter piping

Notes

1) H-Hydraulic; P-Pneumatic

2) For pipe material and service exposure abbreviations, refer to Section 15200-00L.

3) Buried natural gas pipes shall be wrapped with corrosion protection material in accordance with Canadian Gas Code.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	550 mm and smaller	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B, seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Screwed:	
	40 mm & smaller	Schedule 80.
	Welded and Grooved:	
	50 mm thru 250 mm	Schedule 40.
	300 mm thru 400 mm	Schedule 30.
	450 mm thru 550 mm	Standard weight (9.5 mm min. wall thickness).
Linings (Note 2)	All	Shop-Applied Liquid Epoxy Lining: Apply in strict accordance with manufacturer's instructions and requirements of AWWA C210 and Section 09870, including surface cleaning and preparation. For pipe interior, follow System 1, as specified in Section 09870.
Coatings	All	For exposed piping, follow System 5, as specified in Section 09870.
	All	For immersed piping, follow System 1, as specified in Section 09870.
	All	For buried piping, apply coating in accordance with AWWA C214 consisting of at least four layers: 1. Primer layer. 2. Inner Layer Tape: Corrosion-protective tape, 0.5 mm (20 mils), with black exterior. 3. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with gray exterior. 4. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with white exterior. Total tape thickness minimum 2.0 mm (80 mils). Hold back minimum of 60 mm from end of pipe for welded joints.
	All	For concrete encased piping, tape wrap as specified above for buried piping; or alternatively, follow System 5, as specified in Section 09870.
Joints	40 mm & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606. See Note 1.
	50 mm & larger	Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
Fittings	40 mm & smaller	Threaded: 680- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
		Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation, EPDM elastomers for potable water service, rigid style coupling or as otherwise noted. Victaulic; Grinnell.
	50 mm & larger	Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
		Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation, EPDM elastomers for potable water service, rigid style coupling or as otherwise noted. Victaulic Style 44; Grinnell.
		Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained or non-restrained coupling as indicated on Drawings.
Pipe Couplings	75 mm and larger	Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.
		Bolted type sleeve type couplings, restrained or non-restrained as shown; retrained couplings with harness per AWWA M11 and as indicated on the drawings. See Section 15205 – Piping Specialties.
Branch Connections	40 mm & smaller	Threaded, straight, or reducing tees in conformance with Fittings specified above. See Note 1.
	50 mm & larger	Butt-welding or grooved end tee in conformance with Fittings specified above.
Flanges	40 mm & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150, socket-weld or threaded, 1.5 mm raised face.
	50 mm to 100	Forged carbon steel, ASTM A105/A105M, ANSI B16.5, welding neck type, bore to match pipe internal diameter, 1.5 mm raised face.
		Supply and install flat-faced flanges when mating with flat-faced valves and fittings.
		Grooved End Adapter Flange: Malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell.
	150 to 550	AWWA C207, Class D, slip-on.
		Supply and install flat-faced flanges when mating with flat-faced valves and fittings.
Blind Flanges	100 mm and smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150, 1.5 mm raised face.
	200 to 550	Steel, AWWA C207, thickness to suit Class D unless otherwise noted.
Unions	40 mm & smaller	Threaded malleable iron, ASTM A197 or A47, 1035- or 2070 kPag WOG, meeting the requirements of ANSI B16.3.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Couplings	50 mm & larger	Grooved End: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536. Victaulic; Grinnell. Screwed End: Malleable iron, ASTM A197 or A47. See Note 1.
Bolting	Exposed piping	Flanges: Carbon steel ASTM A307, Grade A hex head bolts and ASTM A563, Grade A hex head nuts. Use 3 mm undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 760 MPa minimum tensile strength.
	Submerged and underground	General Conditions: Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	50 mm thru 250 mm	Black neoprene, 2 mm thick, ring type for RF flanges, full face for flat face flanges.
	300 mm and larger	Black neoprene, 3.2 mm thick, ring type for RF flanges, full face for flat face flanges. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110°C.
Thread Lubricant	40 mm & smaller	General Service: Teflon tape.

Notes:

1. Do not use threaded connections on epoxy coated pipe. For small tappings such as vents, drains and gauge connections, supply and install a 50 mm flanged nozzle with a coated blind flange tapped to the size of the required connection.
2. Pipe epoxy lining is required only where indicated on the Piping Schedule 15200-00S.

END OF SECTION

DATA SHEET – CARBON STEEL PIPE AND FITTINGS – LARGE DIAMETER

Item	Size	Description
Pipe	All	Manufactured in accordance with AWWA C200, except as herein modified.
		Fabricated from carbon steel sheet ASTM A1011 (Grades 30, 33, 36 or 40), A907 (Grade 36), or from plate ASTM A36, A283 (Grades C or D), or coil ASTM A139 (Grades B or C).
		Maximum carbon content of 0.25 percent.
		Minimum elongation of 22 percent in a 50.4 mm gauge length.
		Longitudinal and girth seams, whether straight or spiral, shall be butt welded using an approved electric-fusion-weld process.
	Welded and grooved:	
	600 mm	610 mm outside dia., 9.5 mm min. wall thickness
	750 mm	762 mm outside dia., 9.5 mm min. wall thickness
	900 mm	914 mm outside dia., 9.5 mm min. wall thickness
	1050 mm	1067 mm outside dia., 9.5 mm min. wall thickness
	1200 mm	1219 mm outside dia., 9.5 mm min. wall thickness
	1350 mm	1372 mm outside dia., 9.5 mm min. wall thickness
	1500 mm	1543 mm outside dia., 9.5 mm min. wall thickness
	1800 mm	1854 mm outside dia., 12.7 mm min. wall thickness
	2100 mm	2162 mm outside dia., 14.3 mm min. wall thickness
Linings	All	Shop-Applied Liquid Epoxy Lining: Apply in strict accordance with manufacturer's instructions and requirements of AWWA C210 and Section 09870, including surface cleaning and preparation.
		For pipe interior, follow System 1, as specified in Section 09870.
Coatings	All	For exposed piping, follow System 5, as specified in Section 09870.
	All	For immersed piping, follow System 1, as specified in Section 09870.
	All	For buried piping, apply coating in accordance with AWWA C214 consisting of at least four layers: 1. Primer layer. 2. Inner Layer Tape: Corrosion-protective tape, 0.5 mm (20 mils), with black exterior. 3. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with gray exterior.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS – LARGE DIAMETER

Item	Size	Description
Coatings (Continued)	All	4. Outer Layer Tape: Mechanical protective tape, 0.76 mm (30 mils), with white exterior. Total tape thickness minimum 2.0 mm (80 mils). Hold back minimum of 60 mm from end of pipe for welded joints.
	All	For concrete encased piping, tape wrap as specified above for buried piping; or alternatively, follow System 5, as specified in Section 09870.
Joints	All	Exposed: Flanged, butt-welded or restrained flexible coupling. Where shown, provide grooved end meeting the requirements of AWWA C606. Buried or Concrete Encased: Field-welded butt strap with internal welding, double butt-welded or lap welded; AWWA C200, suitable for at least 700 kPa service and, regardless of type, shall be designed to be self-centering. Both bell and spigot ends shall be sized to provide a difference in circumferential measurement between the outside circumference of the spigot and the inside circumference of the bell of not less than 2.3mm and not more than 12.4mm.
Fittings	600 mm to 2100 mm	Fabricated: Carbon steel fabricated from pipe in accordance with AWWA C208; suitable for butt welding, elbows to have a 22.5-degree maximum mitre section angle, minimum of three sections; wyes, tees, crosses, and outlets to be reinforced in accordance with AWWA M11. Formed Fittings: Wrought carbon steel butt-welding type, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, grooved ends to accept couplings without field preparation, EPDM elastomers for potable water service, rigid style coupling or as otherwise noted. Victaulic Style 44; Grinnell. Supply and install Type “D” Vic-ring. Coupling and “D” Vic-Ring shall be supplied by the manufacturer as a package.

DATA SHEET – CARBON STEEL PIPE AND FITTINGS – LARGE DIAMETER

Item	Size	Description
Pipe Couplings	600 mm to 2100 mm	Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings. Bolted type sleeve type couplings, restrained or non-restrained as shown; retrained couplings with harness per AWWA M11 and as indicated on the drawings. See Section 15205 – Piping Specialties.
Flanges	600 mm to 2100 mm	Steel, AWWA C207, Class D, ANSI B16.5, slip-on, flat faced.
Blind Flanges	All	Steel, AWWA C207, thickness to suit Class D unless otherwise noted.
Bolting	Exposed piping	Flanges: Carbon steel ASTM A307, Grade B threaded studs, and ASTM A563, Grade A hex head nuts. Use 3 mm undersize bolting material for insulating flanges. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 760 MPa minimum tensile strength.
	Submerged and underground piping	General Conditions: Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	All flanges	Water Service: 3.2 mm thick, black neoprene, full face type. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110°C.

Notes:
1. For piping 550 mm and smaller follow Specification 15200-03.
2. Do not use threaded connections on epoxy coated pipe. For small tappings such as vents, drains and gauge connections, supply and install a 50 mm flanged nozzle with a coated blind flange tapped to the size of the required connection.
3. Design and install pipe in accordance with AWWA M11, Steel Pipe - A Guide for Design and Installation.

END OF SECTION

DATA SHEET – GALVANIZED STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	All	Galvanized carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B seamless or ERW.
	50 mm & smaller	Schedule 80.
	60 mm to 150 mm	Schedule 40.
	200 mm to 300 mm	Schedule 30.
	350 mm	Standard weight.
Joints	50mm & smaller	Threaded or flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.
	60 mm & larger	Flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.
Fittings		Threaded: 1035- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3. Grooved End: Malleable iron ASTM A47 or ductile iron ASTM A536, 1250 kPa working pressure, grooved ends to accept couplings without field preparation. Victaulic; Grinnell.
Branch Connections	50 mm & smaller	Tee or reducing tee in conformance with Fittings above, galvanized 910 kg WOG thredolet or welding boss; galvanize after welding.
	60 mm & larger	Branch Same Size as Run: Grooved end tee in accordance with Fittings above. Branch One or More Sizes Smaller Than Run: grooved end reducing tee in accordance with Fittings above.
Flanges		Galvanized forged carbon steel, ASTM A105/A105M, ANSI B16.5 Class 150 or Class 300, threaded, 1.5 mm raised face. Grooved end adapter flange, malleable iron ASTM A47 or ductile iron ASTM A536. Victaulic; Grinnell.
Unions		Threaded malleable iron, ASTM A197 or A47, 2070kpag WOG, brass to iron seat, meeting the requirements of ANSI B16.3.
Couplings		Grooved End: Rigid joint malleable iron, ASTM A47 or ductile iron, ASTM A536, 1750 kPa working pressure. Victaulic; Grinnell.
Plugs		Forged carbon steel, ASTM A181/A181M, Grade II, round head, threaded, galvanized.
Bolting		Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 759,000 kPa minimum tensile strength. Flanges: Carbon steel ASTM A307, Grade A hex head

DATA SHEET – GALVANIZED STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
		bolts and ASTM A563, Grade A hex head nuts.
Gaskets	All flanges	Flanged, Water and Sewage Service: 3 mm thick, red rubber (SBR), hardness 80 (Shore A), rated to 93 degrees C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
	Grooved end couplings	EPDM or chlorinated butyl per ASTM D2000 for water, and air to 110°C, dimensions conforming to AWWA C606.
Thread Lubricant	50 mm & smaller	Teflon tape or joint compound that is insoluble in water.

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Pipe	50 mm & smaller	Schedule 40S: ASTM A312/A312M, Type 304 seamless, pickled and passivated.
	60 mm to 150 mm	Schedule 10S: ASTM A778, "as-welded" grade, Type 304L.
	200 mm & larger	Schedule 5S: ASTM A778, "as-welded" grade, Type 304L.
Joints	50 mm & smaller	Threaded or flanged at equipment as required or shown.
	60 mm & larger	Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller	Threaded Forged: 1,000 CWP, ASTM A182/A182M, Grade F304L.
	60 mm & larger	Butt-Welded: ASTM A774/A774M Grade 304L conforming to MSS SP 43, "as-welded" grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	50 mm & smaller	Tee or reducing tee in conformance with Fittings above.
	60 mm & larger	Butt-welding tee or reducing tee in accordance with Fittings above.
Flanges	25 mm & 40 mm	Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ANSI B16.5 Class 150, socketweld, raised face.
	50 mm and larger	Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ANSI B16.5 Class 150 Van Stone Type with stainless steel stub ends, ASTM A240 Type 304L "as-welded grade", conforming to MSS-SP43, wall thickness same as pipe.
Unions	50 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 13800 or 20700 kPag WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Forged Flanges: Type 304 stainless steel, ASTM A320/A320M Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. Van Stone Flanges: Carbon steel ASTM A307 Grade B hex head bolts and ASTM A563 Grade A hex head nuts. Supply and install same on mating cast iron flange on valve or equipment with flat ring gasket.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-GENERAL SERVICE

Item	Size	Description
Gaskets	All Flanges	Flanged, Water and Sewage Service: 5 mm thick, unless otherwise specified, red rubber (SBR), hardness 80 (Shore A), rated to 93 ^{o}C, conforming to ANSI B16.21, AWWA C207, and ASTM D1330, Grades 1 and 2. Flanged, Hot Air and Fuel Gas Service: 3 mm thick, unless otherwise specified, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 150°C, conforming to ANSI B16.21 and ASTM D1330 Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	50 mm & smaller	Teflon tape.

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Item	Size	Description
Pipe	All	ASTM A312/312M Type 316 welded annealed, pickled and passivated. Use Type 316L for welded joints.
	50 mm & smaller	Schedule 40S.
	60 mm to 200 mm	Schedule 10S.
	250 mm & larger	Schedule 10S unless otherwise indicated in the Piping Schedule, Section 15200-00S.
Tubing	19 mm OD & smaller	ASTM A312/A312M Type 316 seamless, soft annealed, 2 mm wall thickness minimum.
Pipe Joints	19 mm & smaller	Threaded or flanged at equipment as required or shown.
	25 mm & 40 mm	Socket weld or flanged at equipment as required or shown.
	50 mm & larger	Butt-welded or flanged at valves and equipment as required or shown.
	100 mm and larger	Grooved end where shown.
Tubing Joints	All	Flareless compression fitting or socket-weld.
Pipe Fittings	19 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 20700 kPag WOG.
	25 mm and 40 mm	Socket Weld Forged: ASTM A182/A182M, Grade F316L, 13800 kPag WOG.
	50 mm & larger	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ANSI B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
	100 mm and larger	Grooved End: Victaulic adapter ring with groove, 316SS, schedule 40, buttwelding connection to adjacent pipe. Rings and coupling specified below shall be supplied by the manufacturer as a package.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F304 or F316, Parker-Hannifin Ferulok, Flodar BA Series. Socket Welded: ASTM A182/A182M, Grade F316L, Cajon, Swagelok.
Pipe Couplings	100 mm and larger	Grooved end coupling, ductile iron, EPDM elastomers for potable water and low pressure air service, rigid style coupling. Victaulic Style 44; Grinnell.
	100 mm and larger	Bolted type sleeve type couplings, restrained or non-restrained as shown; retrained couplings with harness per AWWA M11 and as indicated on the drawings. See Section 15205 – Piping Specialties.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Item	Size	Description
	300 mm and larger	Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.
Pipe Branch Connections	19 mm & smaller	Tee or reducing tee in conformance with Fittings above.
	50 mm & smaller	40 mm and smaller branch: Forged Sockolet or half coupling, 13800kPag WOG ASTM A182/A182M, Grade F316L.
	60 mm & larger	Butt-Welded Tee or Reducing Tee: In accordance with Fittings above Forged Weldolet, 13800 kPag WOG ASTM A182/A182M, Grade F316L same inside diameter as branch pipe.
Tubing Branch Connections	All	Compression type or socket-weld tees or reducing tees in accordance with Tubing Fittings above.
Flanges	25 mm & 40 mm	Forged: ASTM A182/A182M Grade F316L, Class 150, socket weld, 1.5 mm raised face, ANSI B16.5 standard.
	50 mm to 100 mm	Forged: ASTM A182/A182M Grade F316L, Class 150, welding neck, 1.5 mm raised face, ANSI B16.5 standard.
	150 mm and larger	Non-Submerged Service: Cast carbon steel, ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150, Van Stone type with stainless steel stub ends, ASTM A240 Type 316L, conforming to MSS SP 43, wall thickness same as pipe. Submerged Service: Forged steel, ASTM A182/A182M Grade F316L, Class 150, welding neck or slip-on type, 1.5 mm raised face, ANSI B16.5 standard.
Unions	19 mm & smaller	Threaded Forged: ASTM A182/A182M, Grade F316, 910 kg- or 1363 kg WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
	25 mm & 40 mm	Socket Weld Forged: ASTM A182/A182M Rev C Grade F316L, 910 kg- or 1363 kg WOG, integral ground seats, AAR design meeting the requirements of ANSI B16.11, bore to match pipe.
Bolting	All	Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	All Flanges	3.0 mm thick Gore-Tex flat ring type for raised face flanges and full face type for flat face flanges, Garlock, Chesterton. Use 2.0 mm EPDM gaskets for sodium bisulphate service. Grooved Couplings: EPDM per ASTM D2000 for water and air to 110°C.
Thread Lubricant	50 mm & smaller	Teflon tape or Oxyseal; Fleet Supplies, Inc.

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 1

Notes:

1. Refer to Section 15200-000 for special cleaning requirements for oxygen and ozone piping.

END OF SECTION

DATA SHEET – POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

Item	Size	Description
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub type PVC flat face flange in accordance with Fittings above, Class 150 ANSI B16.1 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts.
Gaskets	All	Flat Face Mating Flange: Full faced 3 mm thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 3 mm ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.
Solvent Cement	All	As recommended by the pipe and fitting manufacturer conforming to ASTM D2564, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service. Certification shall be submitted.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

DATA SHEET – FIBREGLASS REINFORCED PLASTIC (FRP) PIPE AND FITTINGS

Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Fibreglass reinforced plastic, helically-wound, conforming to ASTM D2310 Type 1, vinyl ester resin, Derakane 411-45 (Dow Chemical Company) or approved equal, Type C glass monofilament surfacing mat and/or Dynel organic fibre synthetic surfacing veil or approved equal. Constructed in conformance with ASTM D2996. UV Protection: Add to the wax coat Cyabsorb UV-9, as manufactured by American Cyanamid Company.
Fabrication		Interior surfacing veil shall be 0.25 to 0.5 mm (10 to 20 mils) thick. Mat layers shall be resin-rich, fully wetted, 1.3 mm (50 mils) minimum thickness.
	FRP-1 (pipe)	1 layer C-Glass veil 2 mat layers bell-and-spigot or flanged
	FRP-2 (pipe)	1 layer Dynel veil 2 mat layers bell-and-spigot or flanged
	FRP-3 (pipe)	1 layer Dynel veil & 2 mat layers flanged
		1 layer C-Glass veil only
		Cut edges of laminates shall be fully wetted and cured with thinned resin, allowed to cure, then coated with surfacing resin to a DFT of 0.25 to 0.27 mm (10 to 15 mils).
Gaskets	All	1.5 mm thick non-asbestos compression type, full-face, Cranite, Johns Manville.
Special Conditions	FRP-3 (pipe)	Interior layer and inner surfaces shall be free of fillers and thixotropic agents. Completed assemblies shall be post-cured for 2 hours @ 93°C, 6 hours @ 88°C or 16 hours @ 71°C. Field welded joints shall be coated with resin paste before joining.
Ratings		Fibreglass reinforced pipe, fittings and flanges shall be rated 690 kPa as specified in ASTM D2310.
		Minimum continuous strand glass filament (coated with resin) wall thickness for pipe are as follows:
	50 thru 150 mm	4.7 mm
	200 mm	6.4 mm
	250 thru 300 mm	7.9 mm
	350 mm	9.5 mm
	400, 450 mm	11.1 mm
	500 mm	12.7 mm
	600 mm	14.2 mm

DATA SHEET – FIBREGLASS REINFORCED PLASTIC (FRP) PIPE AND FITTINGS

Item	Size	Description
Fittings	All sizes	Fittings: ASTM C582 and D2996. Surface veil and mat layers same as specified above under Ratings. Bends shall be long radius. Structural body of fittings shall be filament wound or built-up with alternate layers of woven roving and chopped stand mat. Filament wound fittings shall be same thickness as specified above under Fabrication.
Flanges		Fibreglass reinforced plastic, faced and drilled 125-pound, ANSI B16.1 standard. Flanges mating with plastic lined steel pipe shall be Van Stone type, ductile iron ASTM A395 or cast steel ASTM A216/A216M Grace WCB, 150-pound standard per ANSI B16.5.
Bolting		Raised Face Flanges: Carbon steel, ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts. Flat Face Flanges in Corrosive Conditions: Stainless steel Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets		Flat Face Flanges: Ethylene propylene rubber (EPR), 3 mm thick, full faced. Raised Face Mating Flange: Ring gasket same material as full face, with filler gasket between OD of raised face and flange OD, thickness same as raised face lip. Van Stone Mating Flange: Tetrafluoroethylene (TFE) envelope type, flat ring gasket.
Colour		Add pigment to the final layer only of exterior surfacing resin to lightly tint the surface, but not obliterate laminate quality. Colors are as follows: FRP-1 Red FRP-2 Green FRP-3 Yellow

Notes: 1. FRP1 pipe and fitting materials shall be suitable for float sludge material from a dissolved air flotation process used in potable water treatment with a max temperature of 25 ^{o}C, addition of ferric chloride and sulphuric acid upstream process resulting in pH range of 5.5 to 7, and system design pressure of 120 kPa.

END OF SECTION

DATA SHEET – COPPER AND COPPER ALLOY PIPE, TUBING AND FITTINGS

Item	Size	Description
General		Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43.
Tubing	75 mm and smaller	Seamless, conforming to ASTM B88 as follows: Water (buried) .....Type K, soft or hard temper Water (exposed) .....Type L, hard drawn Domestic hot water.....Type L, hard drawn Compressed air service.....Type L, hard drawn Refrigerant service .....Type L, hard drawn P-Trap priming service.....Type L, soft temper P-Trap priming service (buried).....Type K, soft or hard temper Sample line service.....Type L, hard drawn Laboratory gas service .....Type L, hard drawn
Tubing	50 mm and smaller	Oxygen service: Seamless, conforming to ASTM B88, Type K, hard drawn.
Fittings	75 mm and smaller	Oxygen Service: Bronze, screwed, 250-pound conforming to ASTM B62, dimensions conforming to ANSI B16.15 or wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ANSI B16.22. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, dimensions conforming to ASME B16.22.
Flanges	All	Oxygen Service: Bronze, screwed, conforming to ASTM B61, faced and drilled 150-pound ANSI B16.24 standard. Other Services: Commercially pure wrought copper, socket joint, conforming to ASTM B75, faced and drilled 150-pound ASME B16.24 standard.
Bolting	All	Oxygen Service: ASTM A320/A320M, stainless steel Type 304, Grade B8 bolts with copper silicon hex nuts conforming to ASTM B98 Grade A hard. Other Services: ASTM A307, carbon steel, Grade A hex head bolts, and ASTM A563 Grade A hex head nuts.
Gaskets	All	1.5 mm thick non-asbestos compression type, full-face, Cranite, Johns Manville.
Solder	All 75 mm and smaller	Oxygen Service: Silver brazing alloy, 15 percent silver content, 640 to 700 ^{o}C melting range, conforming to AWS A5.8. Other Services: Wire solder (95% tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Solder joints in accordance with ANSI B16.22.

Notes:

1. Refer to Section 15200-000 for special cleaning requirements for oxygen and ozone piping.

END OF SECTION

DATA SHEET – HIGH DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS

Item	Size	Description
General	All	Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of the same type, grade, and class of polyethylene compound and supplied from the same raw material supplier. Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	ASTM D3350, high density polyethylene, maximum allowable hoop stress 5.5 MPa (800 psi) at 23 ^{o}C. Polyethylene resins shall conform to Type PE 3408 or better. Protection shall be provided against ultraviolet light degradation using carbon black, not less than 2 percent well dispersed in the resin. Pipe wall thickness shall reflect the required SDR* and diameter, as shown in Table 8, ASTM F714. Design Stress Rating: ASTM F714, 5.5 MPa (800 psi) hydrostatic. Pressure Rating — SDR* 200 — 9 160 — 11 130 — 13.5 100 — 17 80 — 21 65 — 26 50 — 32.5 * SDR: standard dimension ratio = OD/thickness
Fittings	150 mm & smaller	Molded fittings, butt fusion joined, conforming to ASTM D3261.
Flanges	All	Van Stone type, cast ASTM A351/A351M, Type 316 stainless steel backing ring, IPP Deltaflex convoluted design or equal for bolting to ASME B16.1, Class 125; ASME B16.5, Class 150; and AWWA C207, Class E. Pressure performance of the backing ring equal to SDR rating of the pipe with safety factor of two. Stub ends same grade HDPE and pressure rating as pipe.
Bolting	All	General Conditions: Carbon steel, ASTM A307 Grade B square head bolts and ASTM A563 Grade A heavy hex head nuts. Washers shall be same material as bolts.
Gaskets	All	Flat ring, 3 mm ethylene propylene rubber (EPR).

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 2

Item	Size	Description
Pipe	All	ASTM A312/312M Type 316 welded annealed, pickled and passivated. Use Type 316L for welded joints.
	100 mm & smaller	Schedule 40S.
	125 mm thru 200 mm	Schedule 10S.
Pipe Joints	25 thru 50 mm	Butt-welded or flanged at valves and equipment as required or shown.
Pipe Fittings	25 thru 50 mm	Butt Welded: ASTM A403/A403M, Grade WP316L conforming to ANSI B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Pipe Branch Connections	50mm & smaller	Tee or reducing tee in conformance with Fittings above.
	60 mm & larger	Butt-Welded Tee or Reducing Tee: In accordance with Fittings above Forged Weldolet, 13800 kPag WOG ASTM A182/A182M, Grade F316L same inside diameter as branch pipe.
Flanges	All	Forged: ASTM A182/A182M Rev C Grade F316L, Class 150, slip-on welding neck, 1.5 mm raised face, ANSI B16.5 standard.
Bolting	All	General Conditions: Type 316, ASTM A193/A193M, Grade B8M hex head bolts and ASTM A194/A194M Grade 8M hex head nuts.
Gaskets	All Flanges	3.0 mm thick, 150# rating, Teflon ® or Viton ® flat ring type and full face type for flat face flanges.

Notes:

1. All valves used in Hydrogen Peroxide service will be drilled to allow trapped Hydrogen Peroxide gasses to equalize with the upstream side of the valve. If factory drilled valves are not available, field drilling of valves shall be completed by the Contractor.

END OF SECTION

DATA SHEET – STAINLESS STEEL PIPE AND FITTINGS-SPECIAL SERVICE 3

Item	Size	Description
Pipe	All	Seamless stainless steel mechanical tubing, to ASTM A511 Grade 316 Schedule 40S.
Pipe Joints	All	Cold mandrel drawn seamless to ASTM A511
Pipe Fittings	All	316 stainless steel Swagelok or Parker compression fittings

END OF SECTION

DATA SHEET – CARBON STEEL PIPE AND FITTINGS-NATURAL GAS SERVICE

Item	Size	Description
Pipe	All	Black carbon steel, ASTM A106, Grade B seamless or ASTM A53, Grade B, seamless or ERW. Threaded, butt-welded, and flanged joints.
	50 mm & smaller	Schedule 40
	50 mm thru 150 mm	Schedule 40
Joints	50 mm & smaller	Threaded or flanged at valves and equipment.
	65 mm & larger	Butt-welded or flanged at valves and equipment.
Fittings	50 mm & smaller	Threaded: 680- or 2070 kPag malleable iron, ASTM A197 or ASTM A47, dimensions in accordance with ANSI B16.3.
	65 mm & larger	Butt Welded: Wrought carbon steel butt- welding, ASTM A234/A234M, Grade WPB meeting the requirements of ANSI B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Flanges	12 mm thru 150 mm smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ANSI B16.5 Class 150 socket-weld or threaded, 1.5 mm raised face.
Unions	50 mm & smaller	Threaded malleable iron, ASTM A197 or A47, 1035- or 2070 kPag WOG, meeting the requirements of ANSI B16.3.
Bolting	All	Alloy steel stud bolts, ASTM A193/A193M, Grade B7 w/2 heavy hex nuts, ASTM A194/A194M, Grade 2H
Gaskets	12 mm thru 150 mm	3mm thick, black synthetic with SBR binder for severe service, ring type, Class 150, ASME B16.5; Garlock Style 3400

Notes:

1. Install natural gas piping in accordance with CSA B149.1, Natural Gas and Propane Installation Code.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 American Petroleum Institute (API):

.1 API 600, Steel Valves-Flanged and Buttwelding Ends

.2 API 602, Compact Steel Gate Valves-Flanged, Threaded, Welded and Extended-Body Ends

.3 API 608, Metal Ball Valves-Flanged and Butt-Welding Ends

.4 API 609, Butterfly Valves, Lug Type and Wafer Type.

.5 API 589, Valve Inspection and Testing.

.2 ANSI:

.1 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.2 C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

.3 American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.

.4 ASTM:

.1 A276, Standard Specification for Stainless Steel Bars and Shapes.

.2 A351, Standard Specification for Castings, Austenitic, Austenitic-Ferric (Duplex), for Pressure-Containing Parts.

.3 A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

.4 B61, Standard Specification for Steam or Valve Bronze Castings.

.5 B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

.6 B98, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.

.7 B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.

.8 B139, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.

.9 B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

.10 B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.

.11 B584, Standard Specification for Copper Alloy Sand Castings for General Applications.

.12 D429, Test Methods for Rubber Property—Adhesion to Rigid Substrates.

.13 D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

.5 AWWA:

.1 C500, Metal-Seated Gate Valves for Water Supply Service.

.2 C504, Rubber-Seated Butterfly Valves.

.3 C508, Swing-Check Valves for Waterworks Service, 2 in. to 24 in. NPS.

.4 C509, Resilient-Seated Gate Valves for Water Supply Service.

.5 C510, Double Check Valve, Backflow-Preventer Assembly.

.6 C511, Reduced-Pressure Principle Backflow Prevention Assembly.

.7 C540, Power-Actuating Devices for Valves and Sluice Gates.

.8 C550, Protective Epoxy Interior Coatings for Valves and Hydrants.

.9 C606, Grooved and Shouldered Joints.

.10 C800, Underground Service Line Valves and Fittings.

.6 Manufacturers Standardization Society (MSS):

.1 SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.

.2 SP-88, Diaphragm Type Valves.

1.2 Submittals

.1 General:

.1 Provide valve submittals separated in process areas as per drawing key plan:

.1 F: Filtration area

.2 R: Residuals area

.3 O: Ozone area

.4 C: Chemical area

.5 P: DAF area

.6 A: Administration area

.7 M: Main electrical area

.8 I: Raw water pump station area

.9 Y: Yard piping chambers area

.2 Identify process area in the title of all submittal transmittals.

.2 Shop Drawings:

.1 Product data sheets for make and model.

.2 Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

.3 Furnish Shop Drawings for complete actuator assemblies and accessories prior to delivery.

.4 Provide calculations for sizing, noise, cavitation and actuator torque for open-close/throttle and modulating valves. Provide valve coefficient (Cv) versus percent open curves for each size of valve in each process area.

.5 Power and control wiring diagrams, including terminals and numbers.

.6 Complete motor nameplate data.

.7 Submit a completed Instrumentation, Systems, Automation Society (ISA) S20.50 Instrument Specification Sheet for each device.

.3 Information Submittals:

.1 Certificate of compliance for:

.1 Electric operators; full compliance with AWWA C540.

.2 Butterfly valves; full compliance with AWWA C504.

.3 API ANSI classes 300 and 600 valves; full compliance with API standards.

.2 Factory calibration and testing reports: Handwritten reports will not be accepted.

.3 Operation and Maintenance Manual.

.1 API ANSI classes 300 and 600 valves; full compliance with API standards.

.4 Certification of NSF 61B compliance.

2. PRODUCTS

2.1 General

.1 Provide new material only.

.2 All valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, worm and gear operator, operating nut, chain, wrench, and accessories for a complete operation.

.3 Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

.4 Valve same size as adjoining pipe.

.5 Valve ends to suit adjacent piping.

.6 Size operator to operate valve for the full range of pressures and velocities.

.7 Valve to open by turning counterclockwise.

.8 Factory mount operator, actuator, and accessories.

.9 Provide lubricants of the type recommended by the equipment Manufacturer in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, start-up and operation prior to Substantial Performance. Lubrication systems and lubrications shall be certified to ANSI/NSF Standard 61, to be compatible with potable water use.

2.2 Schedules

.1 Requirements relative to this Section are shown on the valve schedules located at the end of this Section.

.2 Refer to Section 15100-00 – Plumbing Piping for valves related to plumbing systems.

.3 Refer to Section 13930 – Fire Suppression System for valves related to the fire pump, standpipe and sprinkler systems.

2.3 Materials

.1 Brass and bronze valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

.1 Approved alloys are of the following ASTM designations: B61, B62, B98 (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

.2 Stainless steel Alloy 18-8 may be substituted for bronze.

2.4 Factory Finishing

.1 Epoxy Lining and Coating:

.1 Use where specified for individual valves described herein.

.2 In accordance with AWWA C550 unless otherwise specified.

.3 Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.

.4 Minimum 0.18 mm dry film thickness except where limited by valve operating tolerances.

.2 Exposed Valves:

.1 In accordance with Division 9 for Painting and Protective Coatings.

.2 Safety isolation valves and lockout valves with handles, handwheels, or chain wheels “safety yellow.”

2.5 Valves

.1 Gate Valves:

.1 Type V100 Gate Valve 50 mm and Smaller:

.1 All-bronze, screwed bonnet, packed gland, single solid wedge gate, nonrising stem, Class 125 rated 1380 kPa CWP, complies with MSS SP-80 Type 1.

.2 Manufacturers and Products:

.1 Crane; Figure 438, NPT threaded ends.

.2 Stockham; Figure B103, NPT threaded ends.

.3 Crane; Figure 1324, soldered ends.

.4 Stockham; Figure B104, soldered ends

.2 Type V108 Gate Valve 65 mm and larger:

.1 Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, Class 125 rated 860 kPa SWP, 1380 kPa CWP for 50 mm through 300 mm, and 690 kPa SWP, 1035 kPa CWP for 350 mm through 600 mm.

.2 Acceptable Manufacturers:

.1 Crane; Figure 461.

.2 Stockham; Figure G612.

.2 Angle Pattern Valve

.1 Type V201 Angle Pattern Valve 50 mm and Smaller:

.1 All-bronze, NPT threaded ends, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 1035 kPa SWP/2670 kPa CWP, complies with MSS SP-80 Type 2.

.2 Acceptable Manufacturers:

.1 Stockham; Figure B-222T.

.2 Crane Co.; Figure 17TF.

.3 Globe Valves:

.1 Type V204 Globe Valve 50 mm and Smaller:

.1 All bronze, screwed ends, union bonnet, inside screw, rising stem, plug type disc, replaceable stainless steel plug and seat, rated 1035 kPa SWP, 2070 kPa WOG.

.2 Acceptable Manufacturers:

.1 Walworth Co.; Figure 3237P.

.2 Stockham; B-62.

.2 Type V210 Globe Valve 50 mm and larger:

.1 Iron body, bronze mounted, flanged ends, bronze seat, outside screw and yoke, bolted bonnet, Class 125 rated 860 kPa SWP/1380 kPa CWP, complies with MSS SP-85 Type 1.

.2 Acceptable Manufacturers:

.1 Stockham; G-512.

.2 Crane; Figure 351.

.3 Type V236 Globe Valve 65 mm and smaller:

.1 All bronze, NPT threaded ends, inside screw-type rising stem, TFE disc, complies with MSS SP-80, rated 2670 kPa CWP.

.2 Acceptable Manufacturers:

.1 Stockham; Figure B-22T.

.2 Crane Co.; Cat. No. 7TF.

.3 Nibco; Figure T-235-Y.

.4 Ball Valves:

.1 Type V300 Ball Valve 50 mm and Smaller for General Water and Air Service:

.1 Two-piece end entry type, bronze body and end piece, hard chrome-plated bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-coated steel hand lever operator with vinyl grip, rated 4140 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Threaded:

.1 Milwaukee; BA100.

.2 Nibco; T-585-70.

.3 Conbraco Apollo; 70-100.

.2 Soldered:

.1 Milwaukee; BA150.

.2 Nibco; S-585-70.

.3 Conbraco Apollo; 70-200.

.2 Type V301 Ball Valve 50 mm and Smaller for Equipment Air System Shutoff:

.1 Two-piece end entry type, bronze body and end piece, hard chrome-plated bronze or brass ball, RTFE seats and packing, blowout-proof stem, 4140 kPa WOG, threaded ends, safety exhaust port to exhaust downstream side when valve is in closed position, zinc-coated steel latch-locking handle with vinyl grip.

.2 Acceptable Manufacturers:

.1 Milwaukee; BA100ELD.

.2 Nibco; T-585-70-SV.

.3 Conbraco Apollo; 75-100-41

.3 Type V304 Ball Valve 50 mm and Smaller for General Water and Air Service:

.1 Three-piece body type, bronze body and end pieces, hard-chrome plated bronze or brass ball, full bore port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 4140 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Threaded Ends:

.1 Milwaukee; BA-300.

.2 Nibco, Inc.; T-595-Y.

.3 Conbraco Apollo; 82-100.

.2 Solder Ends:

.1 Milwaukee; BA-350.

.2 Nibco; S-595-Y.

.3 Conbraco Apollo; 82-200.

.4 Type V305 Ball Valve 65 mm and Smaller for General Water Service:

.1 Two-piece body type, Class 125/150 flanged cast iron or cast steel body, 316 stainless steel ball, full port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, 860 kPa SWP.

.2 Acceptable Manufacturers:

.1 Kitz #90.

.2 Nibco.

.3 Conbraco.

.5 Type V306 Stainless Steel Ball Valve 50 mm and Smaller:

.1 Two piece ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end piece, threaded ends, standard port, ASTM A276 Type 316 stainless steel ball, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 10350 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Milwaukee; 20 Series.

.2 Nibco; T-580-S6-R-66-LL.

.3 Conbraco Apollo; 76-100 Series.

.6 Type V307 Stainless Steel Ball Valve 50 mm and Smaller:

.1 Three-piece ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, threaded ends, reinforced PTFE seats, PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 10350 kPa WOG, 1035 kPa SWP.

.2 Acceptable Manufacturers:

.1 Milwaukee; 20 Series.

.2 Nibco; T-580-S6-R-66-LL.

.3 Conbraco Apollo; 76-100 Series.

.7 Type V308 Stainless Steel Ball Valve 100 mm and Smaller:

.1 ASTM A351/A351M GR CF8M stainless steel body and end pieces, full port Type 316 stainless steel ball, ANSI Class 150 flanged ends, reinforced PTFE or carbon fiber teflon seats, Graphite or PTFE packing, blowout proof stainless steel stem, stainless steel lever operator with vinyl grip.

.2 Acceptable Manufacturers:

.1 Milwaukee; F20 Series.

.2 Nibco; F-515-S6-F-66-FS.

.3 Conbraco Apollo; 87A-100 Series.

.8 Type V309 Stainless Steel Ball Valve 50 mm and Smaller:

.1 316L stainless steel body, 316L stainless steel ball & stem, flanged ends, standard regular service, virgin Teflon PTFE seats/seals, butt-welded ends, vented ball with 3 mm relief port on upstream side, stainless steel lever operator with vinyl grip.

.2 Acceptable Manufacturers:

.1 MCF, SRS 66

.2 Or approved equal

.9 Type V310 PVDF Ball Valve 50 mm and Smaller:

.1 PVDF body, ball and end connectors, full port, Teflon PTFE seats, Viton seal, threaded ends, rated at 1590 kPa working pressures.

.2 Acceptable Manufacturers:

.1 Chemline Plastics Ltd. Type 21

.2 Nibco Tru-Bloc;

.10 Type V320 Vee-Ball Valve, 25 mm to 400 mm:

.1 ANSI Class 150 valve with flanged ends, Type 317 stainless steel body, hard chromium-plated 317 stainless steel ball, splined-type 17-4 PH stainless steel shafts, reinforced PTFE flow-ring seal, reinforced PTFE with stainless steel or Hastalloy sleeve bearings, and PTFE V-ring packing. Valve to have 300:1 rangeability and equal percentage characteristic.

.2 Acceptable Manufacturers:

.1 Fisher Controls: Design V150.

.2 DeZurik: VPB V-Port Ball Valve.

.11 Type V330 PVC Ball Valve 75 mm and Smaller:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru-Bloc.

.2 ASAHI/America; Duo-Bloc.

.3 Spears; True Union.

.12 Type V331 PVC Ball Valve 75 mm and 100 mm:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784 Type I, Grade 1 polyvinyl chloride full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry

design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ANSI B16.1.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru-Bloc.

.2 ASAHI/America; Duo-Bloc.

.5 Plug Valves:

.1 Type V405 Eccentric Plug Valve 75 mm to 300 mm:

.1 Nonlubricated type rated 1208 kPa CWP, drip-tight shutoff with pressure from either direction, cast iron body, exposed and submerged service flanged ends per ANSI B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.

.2 Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N , seats welded nickel, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on stem.

.3 Provide external epoxy coating.

.4 Operators:

.1 75 mm-100 mm Valves: Wrench lever manual, or electric actuator as specified.

.2 150 mm-300 mm Valves: Totally enclosed, geared, manual operator with handwheel, 50 mm nut, or chain wheel. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 50 mm nut.

.5 Acceptable Manufacturers:

.1 Pratt; Ballcentric.

.2 DeZurik; Style PEC.

.3 Milliken; Millcentric Series 600.

.2 Type V407 Eccentric Plug Valve 600 mm to 1200 mm:

.1 Nonlubricated type rated 1035 kPa CWP, drip-tight shutoff with pressure from either direction, cast iron body, exposed and submerged service flanged ends per ANSI B16.1, buried service mechanical joints ends unless otherwise shown, plug

cast iron port opening of no less than 70 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings or U-cups with O-rings of nitrite rubber, grit seal on stem.

.2 Totally enclosed, geared, manual operator with handwheel, 50 mm- nut, or chain wheel, or electric actuator as specified. Size operator for 1.5 times the maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant.

.3 Provide external epoxy coating.

.4 Acceptable Manufacturers:

.1 DeZurik; Style PEC.

.2 Milliken; Millcentric Series 600

.3 Type V460 Stainless Steel Plug Valve 75 mm and smaller:

.1 Oxygen gas service, flanged body, ASTM A351 Grade CF8M 316SS, ANSI class 150, raised face, non-lubricated plug, PTFE sleeve, PTFE/304SS diaphragm top seal, cleaned and bagged for oxygen service, Adjustable wrench operator.

.2 Acceptable Manufacturers:

.1 Xomox Tufline Fig 067-6-6-P1-O-W.

.4 Type V462 Gauge Cock 3 mm-6 mm:

.1 6 mm bronze body, hexagon end pattern, tee head, male ends, rated 862 kPa SWP.

.2 Manufacturer and Product: United Brass Works; Figure 973.

.6 Butterfly Valves:

.1 General:

.1 Valves specified as AWWA C504 to be in full compliance with AWWA C504 and following requirements:

.1 Suitable for throttling operations and infrequent operation after periods of inactivity.

.2 Elastomer seats bonded or vulcanized to body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.

.3 Bubble-tight with rated pressure applied from either side.

.4 No travel stops for disc on interior of body.

.5 Self-adjusting V-type or O-ring shaft seals.

.6 Isolate metal-to-metal thrust bearing surfaces from flowstream.

.7 Stainless steel disc or disc with stainless steel disc edge.

.2 Type V500 Butterfly Valve 75 mm to 1800 mm:

.1 Flanged end, short body type.

.2 AWWA C504, Class 150B.

.3 Cast iron body, cast or ductile iron disc with Type 304 stainless steel shaft, EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.

.4 Painting and Coating

.1 Interior surfaces shall be coated with a protective system in accordance to AWWA Standard C550 – Protective Interior Coatings of Valves and Hydrants, which can be used in a potable water system.

.2 Interior coatings shall comply with ANSI/NSF 61 “Drinking Water System Components – Heath Effects”

.3 Coating shall be two (2) or more layers (0.13 mm, 5 mils, minimum each coat) Polyamide Epoxy, Amerlock 400, Tnemec Series 140F Pota-Pox Plus or approved equal. Application as per Manufacturer’s recommendations.

.4 Coatings shall be holiday free as defined in Section 5.2.3 of AWWA Standard C550.

.5 Exterior surfaces shall be painted consistent with interior surfaces.

.6 Surfaces shall be prepared to NACE SSPC-SP10- Near-White Metal Blast Cleaning

.7 All machined surfaces shall be protected with an approved coating, prior to assembly to prevent rusting. Machined surfaces for valve seats shall have particular attention paid to, as this area if untreated, has proven to support "barnacle growth" which can prevent watertight closure of the valve.

.5 Acceptable Manufacturers:

.1 Pratt

.2 DeZurik

.3 Val-Matic

.3 Type V501 Butterfly Valve General Service 600 mm to 1830 mm:

.1 Flanged end, short body type.

.2 AWWA C504, Class 250B.

.3 Cast iron body, cast or ductile iron disc with Type 316 stainless steel seating edge, Type 316 stainless steel shafts, EPDM rubber seat bonded or molded in body only.

.4 Painting and Coating

.1 Interior surfaces shall be coated with a protective system in accordance to AWWA Standard C550 – Protective Interior Coatings of Valves and Hydrants, which can be used in a potable water system.

.2 Interior coatings shall comply with ANSI/NSF 61 “Drinking Water System Components – Heath Effects”

.3 Coating shall be two (2) or more layers (1.3 mm, 5 mils, minimum each coat) Polyamide Epoxy, Amerlock 400, Tnemec Series 140F Pota-Pox Plus or approved equal. Application as per Manufacturer’s recommendations.

.4 Coatings shall be holiday free as defined in Section 5.2.3 of AWWA Standard C550.

.5 Exterior surfaces shall be painted consistent with interior surfaces.

.6 Surfaces shall be prepared to NACE SSPC-SP10- Near-White Metal Blast Cleaning

.7 All machined surfaces shall be protected with an approved coating, prior to assembly to prevent rusting. Machined surfaces for valve seats shall have particular attention paid to, as this area if untreated, has proven to support "barnacle growth" which can prevent watertight closure of the valve.

.5 Flow control valves (FCV) noted in Automated Valve Schedule shall perform free of cavitation at design conditions for valve positions of 20 percent open or more.

.6 Acceptable Manufacturers:

.1 Pratt

.2 DeZurik

.3 Val-Matic

.4 Type V511 Wafer Style Butterfly Valve, Resilient Seated, 50 mm to 900 mm for Low Pressure Process Air Service:

.1 Flanged style cast iron body, aluminum bronze discs, Type 304 stainless steel one-piece stem, self-lubricating sleeve type bearing, EPDM replaceable resilient seat suitable for operating temperatures up to 121 ^{o}C, 1035 kPa working pressure rating, bubble-tight at 345 kPa differential pressure, externally adjustable bronze packing gland with Buna-N packing, valve body to fit between ANSI Class 125/150 flanges.

.2 Acceptable Manufacturers:

.1 Tyco/Keystone; Figure 106 Series.

.2 Bray Controls; Series 35

.5 Type V512 Lug Butterfly Valve 50 mm to 900 mm for ozone:

.1 Lug style, two-piece cast iron body, one-piece Type 316 stainless steel thin-profile disc and stem, heavy-duty stem bushing, NBR stem seal, FKM (Viton) replaceable resilient seat, 345 kPa pressure bi-directional bubble-tight rating, suitable for temperatures up to 121 ^{o}C, valve body to fit between ANSI Class 125/150 flanges.

.2 Acceptable Manufacturers:

.1 Tyco/Keystone; Model 920.

.2 Bray Controls; Model 21.

.6 Type V513 Butterfly Valve 50 mm and larger:

.1 Wafer style, cast iron body, aluminum bronze or Type 316 stainless steel disc, Type 316 or 18-8 stainless steel one-piece stem, EPDM replaceable resilient seat, heavy-duty self-lubricating sleeve type bushings, NBR stem seal, 1035 kPa working pressure rating, valve body to fit between ANSI Class 125/150 flanges.

.2 Acceptable Manufacturers:

.1 Bray Controls; Series 30.

.2 Tyco/Keystone; Model AR1/AR2.

.3 Crane/Centerline; Series 200.

.7 Type V514 High Performance Butterfly Valve 50 mm to 915 mm:

.1 ANSI Class 150 wafer style, high performance type, Type 316 stainless steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel

shaft and taper pins, EPDM seat, PTFE stem packing, stainless steel with RTFE thrust washer.

.2 Acceptable Manufacturers:

.1 Tyco/Keystone; K-Lok Figure 360/362/370/372 Series.

.2 DeZurik; BHP Series.

.7 Check and Flap Valve:

.1 Type V600 Check Valve, 50 mm and Smaller:

.1 All bronze, threaded cap, threaded or soldered ends, swing type replaceable bronze disc, rated 862 kPa SWP, 1380 kPa WOG.

.2 Acceptable Manufacturers:

.1 Stockham; Figure B-319, threaded ends.

.2 Milwaukee; Figure 509, threaded ends.

.3 Stockham; Figure B-309, soldered ends.

.4 Milwaukee; Figure 1509, soldered ends.

.2 Type V602 Check Valve, 50 mm and Smaller:

.1 All bronze, threaded cap, threaded ends, swing type replaceable Teflon disc and bronze disc holder, rated 1035 kPa SWP, 2070 kPa WOG.

.2 Acceptable Manufacturers:

.1 Walworth; Figure 3412.

.2 Milwaukee; Figure 510.

.3 Type V604 Check Valve 63 mm to 300 mm:

.1 Flanged end, cast iron body, bronze mounted swing type, solid bronze hinges, stainless steel hinge shaft, rated 862 kPa SWG, 1380 kPa WOG.

.2 Acceptable Manufacturers:

.1 Stockham G-931; List 37, Clearway check valve.

.2 Crane Co.; Cat. No. 373.

.4 Type V612 Double Disc Swing Check Valve 50 mm to 1220 mm:

.1 Wafer style, spring loaded, cast iron body, aluminum-bronze or ductile iron discs, Buna-N resilient seats, and Type 316 stainless steel spring, hinge pin, and stop pin.

.2 Valves 50 mm to 300 mm rated 1379 kPa nonshock working pressure and valves 350 mm through 1220 mm rated 1034 kPa nonshock working pressure.

.3 Acceptable Manufacturers:

.1 APCO; Series 9000

.2 Val-Matic; Dual Disc

.3 Crane/Stockham; WG-970

.4 Tyco; Gulf MB Series

.5 Type V614 Slanting Disc Check Valve 50 mm to 1500 mm:

.1 Slanting or tilting disc design, off-center pivot, body ductile iron two-piece design, bronze seat on 55 degree angle, disc bronze or ductile iron, pivot pin and bushing Type 304 stainless steel, Class 125, 1035 kPa rating, Class 125 flange drilling, bottom mounted buffer cylinder for cushion closing, and valve disc position indicator.

.2 Acceptable Manufacturers:

.1 APCO; Series 800.

.2 Val Matic; Series 9800.

.6 Type V617 Wafer Style Check Valve 50 mm to 915 mm:

.1 Wafer style, swing check, one-piece body design, full resilient seal in machined body groove. Type 316 stainless steel body, ASME Class 125 rating, Type 316 stainless steel disc, Type 316 stainless steel spring and other internals, Buna N seal, outside lever assembly, limit switch assembly.

.2 Acceptable Manufacturers:

.1 Tyco; Prince Figure 800 Series

.2 Crane; Uni-Chek II.

.7 Type V618 Wafer Style Check Valve 25 mm to 250 mm:

.1 Class 150 wafer style, silent check. Type 316 stainless steel body, Type 316 stainless steel disc, Type 316 stainless steel spring and other internals.

.2 Acceptable Manufacturers:

.1 Mueller; 101MHT

.2 Or approved equal

.8 Type V619 Wafer Style Check Valve 50 mm and smaller:

.1 Rated for aggressive fluids, Class 150 wafer style, 316L stainless steel body, 316L stainless steel disc, 316L stainless steel spring and other internals.

.2 Acceptable Manufacturers:

.1 Gestra; RK16a

.2 Or approved equal

.9 Type V630 PVC Ball Check Valve 100 mm and Smaller:

.1 ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 1035 kPa at 22 ^{o}C, and Viton seat and seal.

.2 Acceptable Manufacturers:

.1 Nibco; Chemtrol Tru Union.

.2 ASAHI/America.

.3 Spears; True Union.

.10 Type V632 Ball Check Valve 75 mm and Larger:

.1 Flanged end valve with cleanout and sinking type hollow steel ball, vulcanized nitrile rubber exterior, flanges ANSI B16.1, Class 125, rated 1035 kPa working pressure, suitable for vertical up or horizontal flow.

.2 Acceptable Manufacturers:

.1 FLYGT Corp.

.2 Flomatic Corp.;

.3 Golden Anderson.

.11 Type V633 Ball Check Valve 50 mm and smaller:

.1 Rated 1035 kPa at 22.8 ^{o}C, with ASTM D1784, Type I, Grade 1 PVDF body, ball, and stem, end entry, double union design, threaded ends, Teflon coated Viton seal. suitable for vertical up or horizontal flow.

.2 Acceptable Manufacturers:

.1 Chemline Plastics Ltd.

.2 Nibco Chemtrol

.3 Or approved equal.

.12 Type V694 Check Valve 25 mm to 1200 mm:

.1 Elastomer type flanged or slip-on, round entry area to match pipe, contoured duckbilled shaped exit, valve open with approximately 50 mm of line pressure and return to CLOSED position under zero flow condition, flanged, rated for 345 kPa minimum operating pressure; flanges steel backing flange type, drilled to ANSI B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced neoprene.

.2 Manufacturer and Product: Red Valve Co.; Tideflex Check Valve Series 35 or TF-2.

.13 Type V695 Flap Valve 150 mm to 450 mm:

.1 Flap valve for installation on end of pipe to prevent water backup, tight sealing, cast iron or fabricated 316 stainless steel body, brass or 316 stainless steel hinge bar, bearing washers and cotter pins, Class 125 flanged or compression style end connection, resilient seat, 316SS fasteners, neoprene gasket, Manufacturer's standard corrosion resistant epoxy coating.

.2 Acceptable Manufacturers:

.1 Waterman.

.2 Clow.

.3 Fontaine.

.8 Type V711 Pressure-Reducing Valve 50 mm and Larger, Natural Gas:

.1 Natural gas service, direct diaphragm, spring controlled, cast iron body, spring case, internal relief, composition seat and diaphragm, stainless steel valve stem.

.2 Size/Rating: Size for input rating of connected equipment plus 20%, inlet pressure 860 kPa maximum, outlet pressure adjustable between 50 to 750 mm WC, factory set at 300 mm WC.

.3 Acceptable Manufacturers:

.1 Fisher; S202 Series.

.2 Approved equal.

.9 Self-Contained Automatic Valves:

.1 Type V717 Back-Pressure Regulating Valve 50 mm and smaller:

.1 Hydraulically operated, diaphragm actuated, 316L SS body, 12mm tube stub ends, 316L SS actuator, SS handle, Teflon/SS diaphragm facing/backing, standard body, 0-700 kPa control range and maintain a constant back pressure upstream of the valve.

.2 Acceptable Manufacturers:

.1 Go Regulator BP-6 Series

.2 Or approved equal

.2 Type V718 Stainless Steel Pressure-Reducing/Back-Pressure Sustaining Valve 25 mm and Larger:

.1 Hydraulically operated, diaphragm actuated, pilot controlled globe valve, 316 stainless steel body, rated 1208 kPa, ANSI B16.1 flanged ends, stainless steel trim, 316 stainless steel stem, Viton disk, Viton diaphragm, externally mounted strainers with cocks, and maintain a constant downstream pressure while maintaining a minimum upstream pressure.

.2 Valve shall have fusion bonded epoxy coating

.3 Acceptable Manufacturers:

.1 Singer; Model J: 106PR-R

.2 Or approved equal

.3 Type V719 PVC or PVDF Pressure-Reducing/Back-Pressure Sustaining Valve 100 mm and smaller:

.1 Hydraulically operated, diaphragm actuated, pilot controlled globe valve, PVC or PVDF body, flanged ends, Viton seat and stem, PVC or PVDF disk, and maintain a constant back pressure upstream of the valve.

.2 Acceptable Manufacturers:

.1 Chemline SB12

.2 Or approved equal

.4 Type V720 Pressure Relief Valve 25 mm and smaller:

.1 Hydraulically operated, 316 SS body, Viton O-ring, 350-1050 kPa adjustable, Male NPT fittings.

.2 Acceptable Manufacturers:

.1 Swagelok SS-8CPA2-50

.2 Or approved equal

.5 Type V732 Pressure Relief Valve 75 mm and Larger:

.1 Hydraulically operated, diaphragm actuated, pilot controlled globe valve, cast iron, ductile iron, or steel body, ANSI B16.1 flanged ends, rated 1208 kPa, bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks, to open when upstream pressure reaches a maximum set point.

.2 Installed in accordance with AWWA C550.

.3 Size/Rating: 75 mm, set point of 150 kPa (gauge).

.4 Acceptable Manufacturers:

.1 Cla-Val.

.2 Singer.

.3 Watts.

.4 Golden Anderson.

.6 Type V740 Air and Vacuum Valve 13 mm to 400 mm:

.1 13 mm through 75 mm NPT inlets and outlets, 100 mm and larger ANSI B16.1 Class 125 flanged inlet with plain outlet and protective hoods.

.2 Rated 1035 kPa working pressure, cast iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

.3 Acceptable Manufacturers:

.1 APCO Valve and Primer Corp.; Series 140 or 150.

.2 Val-Matic Valve; Series 100.

.7 Type V742 Air and Vacuum Valve 13 mm to 400 mm for Vertical Turbine Service:

.1 13 mm through 75 mm equipped with stainless steel diffuser screen to break up solid water column before coming in contact with float, Manufacturer's standard double acting throttling device in outlet for throttling, NPT threaded inlet and outlet..

.2 100 mm and larger equipped with antislam device to throttle flow of water into air valve. Design antislam device to permit full unrestricted flow of air into and out of air valve but reduce flow area for water to approximately 10 percent. ANSI B16.1 Class 125 flanged inlet and NPT threaded outlet.

.3 Rated 1035 kPa working pressure, cast iron, ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

.4 Acceptable Manufacturers:

.1 APCO Valve and Primer Corp.; Series 141DAT to 146 DAT or Series 1904 to 1916.

.2 Val-Matic Valve; Series 100WS to 116WS.

.8 Type V744 Air Release Valve 13 mm to 150 mm:

.1 Suitable for water service, automatically exhaust small amounts of entrained air that accumulates in a system, in CLOSED position, seat against resilient seat to prevent water leakage.

.2 Rated 1035 kPa working pressure, cast iron, ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512.

.3 Acceptable Manufacturers:

.1 APCO Valve and Primer Corp.; Series 50, 200, and 200A.

.2 Val-Matic Valve; Series 15A to 45.6

.9 Type V771 Pump Control Valve 63 mm to 400 mm:

.1 Hydraulically operated, diaphragm actuated, solenoid controlled globe valve with cast iron body, wye strainer, solenoid c/w manual operator, controllable opening and closing speeds, flanged ends, rated 1208 kPa, stainless steel trim, stainless steel stem, and externally mounted strainer with cock. Designed to eliminate pipeline surges caused by starting and stopping pumps. NSF61 approved fusion bonded epoxy coated internally and externally installed in accordance with AWWA C550

.2 Acceptable Manufacturers:

.1 Cla-Val; Model 60-31

.2 Singer

.10 Type V772 Surge Anticipatory Valve 63 mm to 400 mm:

.1 Hydraulically operated, diaphragm actuated, solenoid controlled globe valve with cast iron body, flanged ends, rated 1208 kPa, stainless steel trim, stainless steel stem, and externally mounted strainer with cock. Designed to eliminate pipeline surges caused by starting and stopping pumps. NSF61 approved fusion bonded epoxy coated internally and externally installed in accordance with AWWA C550.

.2 Acceptable Manufacturers:

.1 Cla-Val; Model 652-03

.2 Singer

.11 Type V773 Solenoid Control Valve 100 mm to 600 mm:

.1 The Solenoid Control Valve shall be an automatic valve designed to either close drip tight or open fully by means of a three-way solenoid control. It is a hydraulically operated, solenoid controlled, diaphragm type globe or angle valve. Hydraulically operated, diaphragm actuated, solenoid controlled globe valve with cast iron body, flanged ends, rated 1208 kPa, stainless steel trim, stainless steel stem, and externally mounted strainer with cock. Designed to close in the event reverse flow is detected in the pipeline utilizing signal from a inline flow meter upstream. Valve shall have capability to de-energize to close. NSF61 approved fusion bonded epoxy coated internally and externally installed in accordance with AWWA C550

.2 Acceptable Manufacturers:

.1 Cla-Val; Model 136-03

.2 Singer

.12 Type V774 Solenoid Control Valve 63 mm to 750 mm:

.1 The valve shall be hydraulically operated, diaphragm actuated, solenoid controlled globe style with cast iron body, flanged ends, rated 1208 kPa, stainless steel trim, stainless steel stem, and externally mounted self cleaning strainer with cock. Designed to close in the event reverse flow is detected in the pipeline upon signal from a pump's reverse sensor signal. The valve shall have reduced port design with maximum pressure loss of less than 48 kPa. The valve shall be designed as de-energize to close in the event of power loss. The valve opening and closing speed shall be adjustable. A limit switch shall be provided with X105 (KX) short stem. NSF61 approved fusion bonded epoxy coated internally and externally installed in accordance with AWWA C550.

.2 Acceptable Manufacturers:

.1 Cla-Val; Model 136-07

.2 Singer

.13 Type V775 Pressure relief Valve 63 mm to 400 mm:

.1 The valve shall be hydraulically operated, diaphragm actuated pressure relief valve, designed to maintain constant pressure at the valve inlet. The pressure relief set-point shall be field adjustable. Pressure relief shall be spring loaded. solenoid controlled globe valve with cast iron body, flanged ends, rated 1208 kPa, stainless steel trim, stainless steel stem, and externally mounted strainer with cock. Valve shall be reduced port with position indicator. Valve shall be reduced port. NSF61 approved fusion bonded epoxy coated internally and externally installed in accordance with AWWA C550

.2 Acceptable Manufacturers:

.1 Cla-Val; Model 650-01

.2 Singer

.10 Miscellaneous Valves:

.1 Type V916 Mud Valve

.1 Stainless steel body and disc, Seal Neoprene ASTM D-2000, gasket between floor and body to be EPDM ASTM 1056, stem guide to be fabricated type 316 L non-rising type 316, ASTM A-276 stem, 50 mm square, manganese bronze operating nut for floor box operation, maximum unsupported stem length of 1.6 m.

.2 Acceptable Manufacturers:

.1 Fontaine Model 85

.2 Type V940 Solenoid Valve 6 mm to 50 mm:

.1 Two-way internal pilot operated diaphragm type, brass body, resilient seat suitable for air or water, solenoid coil molded epoxy, NEMA insulation Class F, 120 volts AC, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Normal position CLOSED when de-energized as indicated.

.2 Minimum operating pressure differential no greater than 35 kPa (gauge), maximum operating pressure differential not less than 863 kPa (gauge).

.3 Acceptable Manufacturers:

.1 ASCO.

.2 Skinner.

.3 Type V942 Solenoid Valve 6 mm to 50 mm:

.1 Two-way solenoid operated valve, PVC body, true-union body style, socket connections, suitable for 10% sodium hypochlorite service, 1035 kPa at 20 ^{o}C.

.2 Solenoid coil molded epoxy, NEMA insulation Class F, 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure NEMA 250, Type 4 unless otherwise indicated. Normal position CLOSED when de-energized unless otherwise noted.

.3 Acceptable Manufacturers:

.1 Hayward.

.2 Approved Equal.

.4 Type V950 Needle Valve:

.1 Service: Instrument air.

.2 Inlet pressure: 40 kPa (g).

.3 Design pressure: 860 kPa (g).

.4 Outlet pressure: 10 kPa.

.5 Connections: 6 mm Swagelok compression fitting.

.6 Body material: brass, bronze or stainless steel.

.7 Cv: 0.35.

.8 Acceptable Manufacturers:

.1 Swagelok

.2 Hoke

2.6 Operators

.1 General

.1 Where indicated in the Automated Valve Schedule – Schedule 15202-01, provide valve gear boxes suitable for submersible operation, with NSF approved food grade lubricant. Provide epoxy coating in accordance with Section 09870 – Coating Systems for Steel Tanks and Pipes, or similar coating systems approved by Contract Administrator.

.2 For submerged valves, provide 316 stainless steel extension stems and support brackets.

.2 Manual Operator:

.1 General:

.1 Operator force not to exceed 175 N (40 lb) under any operating condition, including initial breakaway. Gear reduction operator when force exceeds 175 N.

.2 Operator self-locking type or equipped with self-locking device.

.3 Position indicator on quarter-turn valves.

.4 Worm and gear operators one-piece design worm-gears of gear bronze material. Worm hardened alloy steel with thread ground and polished. Traveling nut type operators threader steel reach rods with internally threaded bronze or ductile iron nut.

.2 Exposed Operator:

.1 Galvanized and painted handwheels.

.2 Lever operators allowed on quarter-turn valves 200 mm and smaller.

.3 Cranks on gear type operators.

.4 Chain wheel operator with tiebacks, extension stem, floor stands, and other accessories to permit operation from normal operation level.

.5 Valve handles to take a padlock, and wheels a chain and padlock.

.3 Buried Operator:

.1 Buried service operators on valves larger than 63 mm shall have a 50 mm AWWA operating nut. Buried operators on valves 50 mm and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.

.2 Design buried service operators for quarter-turn valves to withstand 610 Newton-metre of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 69 kPa.

.3 Buried valves shall have extension stems, bonnets, and valve boxes.

.3 Electric Valve Operators:

.1 General:

.1 Provide actuator suitable for full 90-degree rotation of quarter-turn valves or for use on multi-turn valves, as required.

.2 Comply with AWWA C540.

.3 Size for 1-1/2 times required valve operating torque. The torque required to stall the motor shall not exceed torque rating of the valve.

.4 Provide controls integral with the actuator and fully equipped as specified in AWWA C540.

.5 Include the following features:

.1 Stem protection for rising stem valves.

.2 Handwheel for manual override control of the valve.

.3 Valve position indication.

.4 Visual indicator for position of positioner.

.5 Built-in motor overload protection.

.6 Two single-pole, double-throw (SPDT) type limit switches, field adjustable cam-operated, with contacts rated for 5 A, 120 VAC, housed in actuator control enclosure, factory installed.

.7 Two SPDT torque limit switches, 10A, 125 VAC. The torque limit switches are to be factory preset and field adjustable, housed in actuator control enclosure, factory installed.

.8 Adjustable mechanical limit stops to prevent over-turning of the valve.

.6 Provide all required actuator mounting hardware and accessories.

.7 Provide control devices and actuator as a matched set from the same Manufacturer wherever possible.

.8 Each actuator shall be capable of operating in any horizontal or vertical orientation.

.9 Unless noted otherwise, the actuator shall fail to the last position when the control function or power fails.

.10 Motors shall be rated at 20% intermittent duty cycle.

.11 The actuator speed shall be field adjustable.

.12 Provide a terminal board for field wiring.

.2 Electric Operators, Open-Close Service:

.1 Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.

.2 Operators shall be suitable for positioning of valve at intermediate positions.

.3 Integral OPEN-STOP-CLOSE pushbutton controls.

.4 Reversing motor starter.

.5 Integral COMP-OFF-HAND Selector Switch

.6 Minimum monitoring and control signal requirements:

.1 Open Command Input (from a remote dry contact).

.2 Close Command Input (from a remote dry contact).

.3 Open Status (dry contact for remote indication).

.4 Closed Status (dry contact for remote indication).

.5 Computer (Remote) Mode (dry contact for remote indication).

.6 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

.7 OPEN and CLOSED indicating lights.

.3 Electric Operators, Modulating Service:

.1 Size motors for continuous duty.

.2 Provide feedback potentiometer and integral electronic positioner/comparator circuit to maintain valve position.

.3 Integral OPEN STOP CLOSE pushbutton to control valve in HAND position.

.4 Integral COMP-OFF-HAND Selector Switch

.5 Minimum monitoring and control signal requirements:

.1 COMP-OFF-HAND Selector Switch

.2 Input signal: 4 to 20 mA for position control from programmable logic controller (PLC) when in COMP mode.

.3 Output signal: 4 to 20 mA to PLC for position monitoring

.4 Computer (COMP) Mode (dry Contact for remote indication)

.5 Open Status (dry contact for remote indication)

.6 Closed status (dry contact for remote indication)

.7 Remote dry contacts will be rated 2 Amps at 120 VAC minimum.

.8 OPEN and CLOSED indicating lights.

.9 Valves shall close upon loss of signal unless otherwise indicated.

.10 AC motor with reversing starter or DC motor with solid state reversing controller. Controller capable of 1200 starts per hour.

.11 Duty cycle limit timer and adjustable band width to prevent actuator hunting.

.12 Valve position output converter that generates a 4 to 20 mA dc signal in proportion to valve position, and is capable of driving into loads up to 500 ohm at 24 volts dc.

.6 Actuator Power Supply:

.1 575-volt three-phase or 120-volt single-phase as indicated in the Valve Schedule 15202-01.

.2 Provide control power transformer, 120-volt secondary, if required.

.7 Enclosure:

.1 Provide actuators with NEMA 4 enclosures, suitable for use in an industrial environment.

.2 Provide 120-volt space heaters.

.8 Control Features: Electric actuators with features noted in the Automated Valve Schedule (15202-01).

.9 Acceptable Manufacturers:

.1 Rotork

.2 Limitorque

2.7 Accessories

.1 Tagging: 38 mm diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing the valve tag number shown on the Valve Schedule and/or Drawings.

.2 T-Handled Operating Wrench:

.1 One each galvanized operating wrench, 1.22 metre long.

.2 Acceptable Manufacturers:

.1 Mueller; No. A-24610.

.2 Clow No.; F-2520.

.3 One each galvanized operating key for cross handled valves.

.3 Extension Bonnet for Valve Operator: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.

.1 Acceptable Manufacturers:

.1 Pratt

.2 DeZurik

.4 Floor Stand and Extension Stem:

.1 Nonrising, indicating type.

.2 Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment.

.3 Stem Guide: Space such that stem L/R ratio does not exceed 200.

.4 Anchor Bolts: Type 304 SST.

.5 Acceptable Manufacturers:

.1 Clow; Figure F-5515.

.2 Mueller, Figure A-26426.

.5 Floor Box and Extension Stem:

.1 Plain type, for support of nonrising type stem.

.2 Complete with solid extension stem, operating nut, and stem guide brackets.

.3 Stem Guide: Space such that stem L/R ratio does not exceed 200.

.4 Anchor Bolts: Type 304 SST.

.5 Acceptable Manufacturers:

.1 Neenah Foundry; R 7506.

.2 Clow; No. F5690.

.6 Chain Wheel and Guide:

.1 Handwheel direct-mount type.

.2 Complete with chain.

.3 Galvanized or cadmium-plated.

.4 Acceptable Manufacturers:

.1 Clow Corp.; Figure F-5680.

.2 Walworth Co.; Figure 804.

.3 DeZurik Corp.; Series W or LWG.

3. EXECUTION

3.1 Installation by Contractor

.1 Flange Ends:

.1 Flanged valve boltholes shall straddle vertical centerline of pipe.

.2 Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

.2 Screwed Ends:

.1 Clean threads by wire brushing or swabbing.

.2 Apply joint compound.

.3 PVC and CPVC Valves: Install using solvents approved for valve service conditions.

.4 Valve Orientation:

.1 Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 1476 mm or less above finished floor, unless otherwise shown.

.2 Install operating stem horizontal in horizontal runs of pipe having centerline elevations between 1476 mm and 2057 mm above finish floor, unless otherwise shown.

.3 Orient butterfly valve shaft so that unbalanced flows or eddies are equally divided to each half of the disc, i.e., shaft is in the plane of rotation of the eddy.

.4 If no plug valve seat position is shown, locate as follows:

.1 Horizontal Flow: The flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve.

.2 Vertical Flow: Install seat in the highest portion of the valve.

.5 Install a line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

.6 Install safety isolation valves on compressed air.

.7 Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

.8 Extension Stem for Operator: Where the depth of the valve is such that its centreline is more than 1000 mm below grade, furnish an operating extension stem with 50 mm operating nut to bring the operating nut to a point 150 mm below the surface of the ground and/or box cover.

.9 Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of the valve.

.10 Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

.11 Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on all manually operated valves with stem centrelines more than 2000 mm above the operating floor or grade. Chains shall extend to within 1200 mm of the operating floor or grade. Chain wheel and guide assemblies shall also be provided for valves as specified in Section 15202-02, Manual Valve Schedule. Where chains hang in normally travelled areas, use "L" type tie-back anchors.

3.2 Field Finishing by Contractor

.1 Equipment as specified in Section 09901, Painting and Finishing – Process Mechanical.

3.3 Field Quality Control by Contractor

.1 Demonstration Tests: Conduct position and travel tests on each valve locally and remotely if automated. Provide checklist of functional testing for all valves in 15202-01 and 15202-02.

.2 Performance Test: In accordance with operating conditions indicated in supplemental valve schedules sheets.

.3 Valve may be either tested while testing pipelines, or as a separate step.

.4 Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

.5 Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

.6 Count and record number of turns to open and close valve; account for any discrepancies with Manufacturer's data.

.7 Set, verify, and record set pressures for all relief and regulating valves.

.8 Automatic valves to be tested in conjunction with control system testing. Set all opening and closing speeds, limit switches, as required or recommended by the Contract Administrator.

.9 Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 1.24 litre/min/metre of seat periphery.

3.4 Manufacturer's Representative Field Services

.1 The valve(s) as listed below require Manufacturer's field services:

.1 Valves in the Automated Valve Schedule

.2 Valves in the Manual Valve Schedule as follows:

.1 PSVs

.2 Valves with limit switches

.2 Verify satisfactory delivery of the equipment by completing Form 100, illustrated in Section 01650 – Equipment Installation.

.3 Instruct Contractor in the methods and precautions to be followed in the installation of the equipment. Certify the Contractor's understanding by completing Form 101, illustrated in Section 01650 – Equipment Installation.

.4 Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

.5 The minimum periods of Site attendance as total number of business days for all equipment are identified in the following table along with the form to be completed on each of these trips.

.6 The total number of trips will depend on the Contractor's schedule. The cost of additional trips, to be determined by the Contract Administrator, will be borne by the Contractor. Arrange for a technically qualified Manufacturer's Representative to attend the installation work, certify correct installation, train operating and maintenance staff and undertake the testing of the system for sufficient periods, to ensure the equipment is installed, operated, and maintained in accordance with the Manufacturer's recommended procedures.

Item	Description	Total number of business days	Form
1	Equipment Delivery	1	100
2	Installation Assistance	1	101
3	Witnessing of Equipment Installation	6	102
4	Assistance in Equipment Performance Testing	6	103
5	Operator and Maintenance Training	4	T1

3.5 Installation Witnessing

.1 The Contractor shall ensure that equipment is installed plumb, square and true within tolerances specified by the Manufacturer's Representative and as indicated in the Contract Documents.

.2 The Manufacturer's Representative shall ensure the equipment is installed as required to provide satisfactory service.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for a successful installation as documented by Form 102, illustrated in Section 01650 – Equipment Installation.

3.6 Equipment Performance Testing

.1 The Manufacturer's Representative shall ensure that each pump, including all component parts, operates as intended.

.2 The Manufacturer's Representative shall demonstrate satisfaction of requirements specified herein.

.3 The Manufacturer's Representative and the Contractor are to cooperate to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650 – Equipment Installation.

3.7 Training

.1 The Manufacturer's Representative shall provide the services of factory trained instructors for the purpose of training the City's personnel in the proper operation and maintenance of the equipment as documented by Form T1. Conform to the requirements of Section 01650 – Equipment Installation.

3.8 Supplements

.1 The supplements listed below, following "End of Section," are part of this Specification.

.1 15202-01 - Automated Valves.

.2 15202-02 - Manual Valves.

END OF SECTION

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Actuator Service	Actuator Type (P - PNEUMATIC, S - SOLENOID, E - ELECTRIC)	Voltage	Comments/ Control Features
RWPS Area											
DAF Area											
WP - P0001	FV - I014D	Butterfly	V500	RW	300	Exposed	115	Open/Close	E	575	Epoxy coated steel
WP - P0001	FV - I014E	Butterfly	V500	RW	300	Exposed	115	Open/Close	E	575	
WP - P0002	FCV - P100A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0002	FCV - P200A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0002	FCV - P300A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0002	FCV - P400A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0003	FCV - P500A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0003	FCV - P600A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0003	FCV - P700A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0003	FCV - P800A	Butterfly	V501	RW	450	Exposed	98	Fully modulating	E	575	Normal flow range 26 to 52 ML/d
WP - P0012	FV - P020D	Butterfly	V500	CRW	250	Exposed	98	Open/Close	E	575	SST
WP - P0012	FV - P020E	Butterfly	V500	CRW	250	Exposed	98	Open/Close	E	575	
WP - P0014	FV - P050D	Butterfly	V500	CRW	250	Exposed	98	Open/Close	E	575	
WP - P0014	FV - P050E	Butterfly	V500	CRW	250	Exposed	98	Open/Close	E	575	
Ozone Area											
Filtration Area											
WF - P0001	FV - F101A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0001	FV - F102A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0001	FCV - F103A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0001	FV - F104A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0001	FV - F105A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0001	FV - F106A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0001	FV - F107A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0002	FV - F201A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0002	FV - F202A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0002	FCV - F203A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0002	FV - F204A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0002	FV - F205A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0002	FV - F206A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0002	FV - F207A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0003	FV - F301A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0003	FV - F302A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0003	FCV - F303A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0003	FV - F304A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0003	FV - F305A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0003	FV - F306A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0003	FV - F307A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0004	FV - F401A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0004	FV - F402A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0004	FCV - F403A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0004	FV - F404A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0004	FV - F405A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0004	FV - F406A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0004	FV - F407A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0005	FV - F501A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Actuator Service	Actuator Type (P - PNEUMATIC, S - SOLENOID, E - ELECTRIC)	Voltage	Comments/ Control Features
WF - P0005	FV - F502A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0005	FCV - F503A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0005	FV - F504A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0005	FV - F505A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0005	FV - F506A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0005	FV - F507A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0006	FV - F601A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0006	FV - F602A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0006	FCV - F603A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0006	FV - F604A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0006	FV - F605A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0006	FV - F606A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0006	FV - F607A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0007	FV - F701A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0007	FV - F702A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0007	FCV - F703A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0007	FV - F704A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0007	FV - F705A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0007	FV - F706A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0007	FV - F707A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0008	FV - F801A	Butterfly	V500	FIN	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0008	FV - F802A	Butterfly	V500	BWW	900	Submerged	170	Open/Close	E	575	Side Submerged Gearbox.
WF - P0008	FCV - F803A	Butterfly	V501	FW	600	Exposed	170	Fully modulating	E	575	Normal flow range 29 to 58 ML/d
WF - P0008	FV - F804A	Butterfly	V500	FW	600	Exposed	170	Open/Close	E	575	
WF - P0008	FV - F805A	Butterfly	V500	FTR	600	Exposed	170	Open/Close	E	575	
WF - P0008	FV - F806A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0008	FV - F807A	Butterfly	V511	AS	300	Exposed	170	Open/Close	E	575	
WF - P0009	FV - F910A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0009	FCV - F911A	Butterfly	V501	BWS	750	Exposed	170	Fully modulating	E	575	Normal flow range 19 to 102 ML/d, normally fully open.
WF - P0009	FV - F912A	Butterfly	V500	FTR	750	Exposed	170	Open/Close	E	575	
WF - P0009	FV - F920A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0009	FCV - F921A	Butterfly	V501	BWS	750	Exposed	170	Fully modulating	E	575	Normal flow range 19 to 102 ML/d, normally fully open.
WF - P0009	FV - F922A	Butterfly	V500	FTR	750	Exposed	170	Open/Close	E	575	
WF - P0009	FV - F931A	Butterfly	V500	FTR	750	Exposed	170	Open/Close	E	575	Remote Swith (handswitch mounted remotely from valve actuator)
WF - P0009	FV - F932A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	
WF - P0009	FV - F933A	Butterfly	V500	BWS	900	Exposed	170	Open/Close	E	575	Provide with torque tube 914 mm above FL EL
WF - P0009	FV - J991A	Solenoid	V942	HYP	25	Exposed	350	Open/Close	S	120	Materials to be compatible with 10% sodium hypochlorite
WF - P0009	FV - J992A	Solenoid	V942	HYP	25	Exposed	350	Open/Close	S	120	Materials to be compatible with 10% sodium hypochlorite
WF - P0010	FV - F010A	Butterfly	V511	AS	350	Exposed	170	Open/Close	E	575	
WF - P0010	FV - F020A	Butterfly	V511	AS	350	Exposed	170	Open/Close	E	575	
WF - P0011	FV - F051A	Butterfly	n/a	FW	1350	Exposed	170	Open/Close	E	575	City Supplied Equipment
WF - P0011	FV - F052A	Butterfly	n/a	FW	1350	Exposed	170	Open/Close	E	575	City Supplied Equipment
WF - P0014	FV - J701C	Butterfly	V500	FW	100	Exposed	170	Open/Close	E	575	
WF - P0014	FV - J702C	Butterfly	V500	FW	100	Exposed	170	Open/Close	E	575	
WF - P0014	FV - J703C	Butterfly	V500	FW	100	Exposed	170	Open/Close	E	575	
Chemical Area											
WC - P0001	FV - C810B	Butterfly	V514	HP	75	Exposed	170	Open/Close	E	120	
WC - P0001	FV - C820	Butterfly	V514	HP	75	Exposed	170	Open/Close	E	120	
WC - P0003	HV C940J	Butterfly	V514	SBS	75	Exposed	170	Open/Close	E	575	

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Actuator Service	Actuator Type (P - PNEUMATIC, S - SOLENOID, E - ELECTRIC)	Voltage	Comments/ Control Features
Residuals Area											
WR - P0002	FV - R100A	Plug	V407	SUP	750	Submerged	1305	Open/Close	E	575	Sub. gearbox, pedestal,electric actuator,mounting access.,epoxy in/out
WR - P0003	FV - R200A	Plug	V407	SUP	750	Submerged	1305	Open/Close	E	575	Sub. gearbox, pedestal,electric actuator,mounting access.,epoxy in/out
WR - P0004	FV - R300A	Plug	V407	SUP	750	Submerged	1305	Open/Close	E	575	Sub. gearbox, pedestal,electric actuator,mounting access.,epoxy in/out
WR - P0005	FV - R400A	Plug	V407	SUP	750	Submerged	1305	Open/Close	E	575	Sub. gearbox, pedestal,electric actuator,mounting access.,epoxy in/out
WR - P0007	FV - R021B	PCV	V771	SUP	300	Exposed	1208	Open/Close	Self Contained	120	Solenoid control
WR - P0007	FV - R022B	PCV	V771	SUP	300	Exposed	1208	Open/Close	Self Contained	120	Solenoid control
WR - P0007	FV - R023B	PCV	V771	SUP	300	Exposed	1208	Open/Close	Self Contained	120	Solenoid control
WR - P0007	FV - R024B	PCV	V773	SUP	600	Exposed	1208	Open/Close	Self Contained	120	Solenoid control
WR - P0007	PRV - R024A	Globe	V772	SUP	300	Exposed	1208	Open/Close	-	-	Reduced port,hydraulic
WR - P0009	FV - R730A	Globe	V774	SLU	100	Exposed	1208	Open/Close	Self Contained	120	Hydraulic, Solenoid control
WR - P0009	PRV - R730A	Globe	V775	SLU	100	Exposed	1208	Open/Close	-	-	Reduced port, Hydraulic
WR - P0009	FV - R710A	Plug	V405	SLU	200	Submerged	150	Modulating	E	575	Internal and external epoxy coating
WR - P0009	FV - R720A	Plug	V405	SLU	200	Submerged	150	Modulating	E	575	Internal and external epoxy coating

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
Filtration Area								
WF - P0001	HV - F100A	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100B	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100C	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100D	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100E	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100F	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100G	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100H	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100J	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100K	Ball	V307	FIN	12	Exposed	170	
WF - P0001	HV - F100L	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100M	Ball	V307	FW	12	Exposed	170	
WF - P0001	HV - F100N	Butterfly	V500	FW	100	Exposed	170	
WF - P0001	HV - F100P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0001	HV - F103A	Ball	V304	FW	50	Exposed	170	
WF - P0001	HV - F107A	Ball	V304	AS	50	Exposed	170	
WF - P0001	HV - F108A	Butterfly	V500	FED	100	Exposed	170	
WF - P0001	HV - F110A	Ball	V304	FW	12	Exposed	170	
WF - P0001	HV - F110C	Ball	V304	FW	12	Exposed	170	
WF - P0001	HV - F110D	Ball	V304	FW	12	Exposed	170	
WF - P0001	HV - F110E	Ball	V304	FW	12	Exposed	170	
WF - P0001	HV - F110F	Ball	V304	FW	12	Exposed	170	
WF - P0001	HV - F110G	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F200A	Ball	V307	FIN	12	Exposed	170	
WF - P0002	HV - F200B	Ball	V307	FIN	12	Exposed	170	
WF - P0002	HV - F200C	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200D	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200E	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200H	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200J	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200M	Ball	V307	FW	12	Exposed	170	
WF - P0002	HV - F200N	Butterfly	V500	FW	100	Exposed	170	
WF - P0002	HV - F200P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0002	HV - F203A	Ball	V304	FW	50	Exposed	170	
WF - P0002	HV - F207A	Ball	V304	AS	50	Exposed	170	
WF - P0002	HV - F208A	Butterfly	V500	FED	100	Exposed	170	
WF - P0002	HV - F210A	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F210C	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F210D	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F210E	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F210F	Ball	V304	FW	12	Exposed	170	
WF - P0002	HV - F210G	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F300A	Ball	V307	FIN	12	Exposed	170	
WF - P0003	HV - F300B	Ball	V307	FIN	12	Exposed	170	
WF - P0003	HV - F300C	Ball	V307	FW	12	Exposed	170	
WF - P0003	HV - F300D	Ball	V307	FW	12	Exposed	170	
WF - P0003	HV - F300E	Ball	V307	FW	12	Exposed	170	
WF - P0003	HV - F300H	Ball	V307	FW	12	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0003	HV - F300J	Ball	V307	FW	12	Exposed	170	
WF - P0003	HV - F300M	Ball	V307	FW	12	Exposed	170	
WF - P0003	HV - F300N	Butterfly	V500	FW	100	Exposed	170	
WF - P0003	HV - F300P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0003	HV - F303A	Ball	V304	FW	50	Exposed	170	
WF - P0003	HV - F307A	Ball	V304	AS	50	Exposed	170	
WF - P0003	HV - F308A	Butterfly	V500	FED	100	Exposed	170	
WF - P0003	HV - F310A	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F310C	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F310D	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F310E	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F310F	Ball	V304	FW	12	Exposed	170	
WF - P0003	HV - F310G	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F400A	Ball	V307	FIN	12	Exposed	170	
WF - P0004	HV - F400B	Ball	V307	FIN	12	Exposed	170	
WF - P0004	HV - F400C	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400D	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400E	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400H	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400J	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400M	Ball	V307	FW	12	Exposed	170	
WF - P0004	HV - F400N	Butterfly	V500	FW	100	Exposed	170	
WF - P0004	HV - F400P	Butterfly	V500	DRN	100	Exposed	170	
WF - P0004	HV - F403A	Ball	V304	FW	50	Exposed	170	
WF - P0004	HV - F407A	Ball	V304	AS	50	Exposed	170	
WF - P0004	HV - F408A	Butterfly	V500	FED	100	Exposed	170	
WF - P0004	HV - F410A	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F410C	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F410D	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F410E	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F410F	Ball	V304	FW	12	Exposed	170	
WF - P0004	HV - F410G	Ball	V304	FW	12	Exposed	170	
WF - P0005	HV - F500A	Ball	V307	FIN	12	Exposed	170	
WF - P0005	HV - F500B	Ball	V307	FIN	12	Exposed	170	
WF - P0005	HV - F500C	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500D	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500E	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500H	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500J	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500M	Ball	V307	FW	12	Exposed	170	
WF - P0005	HV - F500N	Butterfly	V500	FW	100	Exposed	170	
WF - P0005	HV - F500P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0005	HV - F503A	Ball	V304	FW	50	Exposed	170	
WF - P0005	HV - F507A	Ball	V304	AS	50	Exposed	170	
WF - P0005	HV - F508A	Butterfly	V500	FED	100	Exposed	170	
WF - P0005	HV - F510A	Ball	V304	FW	12	Exposed	170	
WF - P0005	HV - F510C	Ball	V304	FW	12	Exposed	170	
WF - P0005	HV - F510D	Ball	V304	FW	12	Exposed	170	
WF - P0005	HV - F510E	Ball	V304	FW	12	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0005	HV - F510F	Ball	V304	FW	12	Exposed	170	
WF - P0005	HV - F510G	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F600A	Ball	V307	FIN	12	Exposed	170	
WF - P0006	HV - F600B	Ball	V307	FIN	12	Exposed	170	
WF - P0006	HV - F600C	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600D	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600E	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600H	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600J	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600M	Ball	V307	FW	12	Exposed	170	
WF - P0006	HV - F600N	Butterfly	V500	FW	100	Exposed	170	
WF - P0006	HV - F600P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0006	HV - F603A	Ball	V304	FW	50	Exposed	170	
WF - P0006	HV - F607A	Ball	V304	AS	50	Exposed	170	
WF - P0006	HV - F608A	Butterfly	V500	FED	100	Exposed	170	
WF - P0006	HV - F610A	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F610C	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F610D	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F610E	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F610F	Ball	V304	FW	12	Exposed	170	
WF - P0006	HV - F610G	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F700A	Ball	V307	FIN	12	Exposed	170	
WF - P0007	HV - F700B	Ball	V307	FIN	12	Exposed	170	
WF - P0007	HV - F700C	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700D	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700E	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700H	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700J	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700M	Ball	V307	FW	12	Exposed	170	
WF - P0007	HV - F700N	Butterfly	V500	FW	100	Exposed	170	
WF - P0007	HV - F700P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0007	HV - F703A	Ball	V304	FW	50	Exposed	170	
WF - P0007	HV - F707A	Ball	V304	AS	50	Exposed	170	
WF - P0007	HV - F708A	Butterfly	V500	FED	100	Exposed	170	
WF - P0007	HV - F710A	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F710C	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F710D	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F710E	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F710F	Ball	V304	FW	12	Exposed	170	
WF - P0007	HV - F710G	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F800A	Ball	V307	FIN	12	Exposed	170	
WF - P0008	HV - F800B	Ball	V307	FIN	12	Exposed	170	
WF - P0008	HV - F800C	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800D	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800E	Ball	V307	FIN	12	Exposed	170	
WF - P0008	HV - F800F	Ball	V307	FIN	12	Exposed	170	
WF - P0008	HV - F800G	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800H	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800J	Ball	V307	FIN	12	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0008	HV - F800K	Ball	V307	FIN	12	Exposed	170	
WF - P0008	HV - F800L	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800M	Ball	V307	FW	12	Exposed	170	
WF - P0008	HV - F800N	Butterfly	V500	FW	100	Exposed	170	
WF - P0008	HV - F800P	Butterfly	V500	DRN	75	Exposed	170	
WF - P0008	HV - F803A	Ball	V304	FW	50	Exposed	170	
WF - P0008	HV - F807A	Ball	V304	AS	50	Exposed	170	
WF - P0008	HV - F808A	Butterfly	V500	FED	100	Exposed	170	
WF - P0008	HV - F810A	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F810C	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F810D	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F810E	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F810F	Ball	V304	FW	12	Exposed	170	
WF - P0008	HV - F810G	Ball	V304	FW	12	Exposed	170	
WF - P0009	HV - F910A	Butterfly	V500	DRN	75	Exposed	170	
WF - P0009	HV - F910B	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F910C	Ball	V304	BWS	50	Exposed	170	
WF - P0009	ARV - F911A	Air Release	V740	VTA	75	Exposed	170	
WF - P0009	CV - F911A	Check	V612	BWS	750	Exposed	170	
WF - P0009	HV - F911A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F911B	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F911C	Ball	V304	VTA	75	Exposed	170	
WF - P0009	HV - F911D	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F911E	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F911F	Ball	V304	BWS	25	Exposed	170	
WF - P0009	HV - F911G	Ball	V304	BWS	25	Exposed	170	
WF - P0009	HV - F912A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F913A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F920A	Butterfly	V500	DRN	75	Exposed	170	
WF - P0009	HV - F920B	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F920C	Ball	V304	BWS	50	Exposed	170	
WF - P0009	ARV - F921A	Air Release	V740	VTA	75	Exposed	170	
WF - P0009	CV - F921A	Check	V612	BWS	750	Exposed	170	
WF - P0009	HV - F921A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F921B	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F921C	Ball	V304	VTA	75	Exposed	170	
WF - P0009	HV - F921D	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F921E	Ball	V304	BWS	50	Exposed	170	
WF - P0009	HV - F921F	Ball	V304	BWS	25	Exposed	170	
WF - P0009	HV - F921G	Ball	V304	BWS	25	Exposed	170	
WF - P0009	HV - F922A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	HV - F923A	Ball	V304	DRN	50	Exposed	170	
WF - P0009	ARV - F931A	Air Release	V740	VTA	75	Exposed	170	
WF - P0009	HV - F931A	Ball	V320	FTR	75	Exposed	170	
WF - P0009	ARV - F931B	Air Release	V740	VTA	75	Exposed	170	
WF - P0009	HV - F931B	Ball	V320	FTR	75	Exposed	170	
WF - P0009	BPV - J991A	Back Pressure Valve	V719	HYP	25	Exposed	170	
WF - P0009	FV J991A	Globe	V204	HYP	25	Exposed	170	
WF - P0009	HV - J991A	Ball	V330	HYP	25	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0009	HV - J991A	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991B	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991B	Ball	V330	HYP	25	Exposed	170	c/w operating nut and key, Epoxy coat
WF - P0009	CV - J991C	Check	V602	HYP	25	Exposed	170	
WF - P0009	CV - J991C	Check	V602	HYP	25	Exposed	170	
WF - P0009	HV - J991C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991E	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991E	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J991F	Ball	V330	HYP	25	Exposed	170	
WF - P0009	BPV - J992A	Back Pressure Valve	V718	HYP	25	Exposed	170	
WF - P0009	FV - J992A	Globe	V204	HYP	25	Exposed	170	
WF - P0009	HV - J992A	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992A	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992B	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992B	Ball	V330	HYP	25	Exposed	170	
WF - P0009	CV - J992C	Check	V602	HYP	25	Exposed	170	
WF - P0009	CV - J992C	Check	V602	HYP	25	Exposed	170	
WF - P0009	HV - J992C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992E	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J992E	Ball	V330	HYP	25	Exposed	170	could submerge, epoxy coat, op. nut/key
WF - P0009	HV - J992F	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J993B	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J993B	Ball	V330	HYP	25	Exposed	170	could submerge, epoxy coat, op. nut/key
WF - P0009	CV - J993C	Check	V602	HYP	25	Exposed	170	
WF - P0009	CV - J993C	Check	V602	HYP	25	Exposed	170	Could submerge, epoxy coat, op. nut/key
WF - P0009	HV - J993C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J993C	Ball	V330	HYP	25	Exposed	170	Sinking, Poss. Submerged, Epoxy coat
WF - P0009	HV - J993D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J993D	Ball	V330	HYP	25	Exposed	170	Sinking, Poss. Submerged, Epoxy coat
WF - P0009	HV - J993E	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J993E	Ball	V330	HYP	25	Exposed	170	Potential for Submergence, Epoxy coat
WF - P0009	HV - J994B	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J994B	Ball	V330	HYP	25	Exposed	170	Potential for Submergence, Epoxy coat
WF - P0009	CV - J994C	Check	V602	HYP	25	Exposed	170	
WF - P0009	CV - J994C	Check	V602	HYP	25	Exposed	170	Potential for Submergence, Epoxy coat
WF - P0009	HV - J994C	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J994C	Ball	V330	HYP	25	Exposed	170	Sinking, Poss. Submerged, Epoxy coat
WF - P0009	HV - J994D	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J994D	Ball	V330	HYP	25	Exposed	170	Sinking, Poss. Submerged, Epoxy coat
WF - P0009	HV - J994E	Ball	V330	HYP	25	Exposed	170	
WF - P0009	HV - J994E	Ball	V330	HYP	25	Exposed	170	Supplied with Instrument Package
WF - P0010	CV - F010A	Check	V617	AS	350	Exposed	170	
WF - P0010	HV - F010A	Butterfly	V511	AS	300	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0010	HV - F010B	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F010C	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F010D	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F010E	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F010F	Ball	V307	AS	12	Exposed	170	
WF - P0010	CV - F020A	Check	V617	AS	350	Exposed	170	
WF - P0010	HV - F020A	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F020B	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F020C	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F020D	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F020E	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F020F	Ball	V307	AS	12	Exposed	170	
WF - P0010	HV - F107B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F207B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F307B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F407B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F507B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F607B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F707B	Butterfly	V511	AS	300	Exposed	170	
WF - P0010	HV - F807B	Butterfly	V511	AS	300	Exposed	170	
WF - P0011	HV - F051B	Ball	V331	FW	75	Exposed	170	
WF - P0011	HV - F052B	Ball	V331	FW	75	Exposed	170	
WF - P0011	HV - F056A	Ball	V304	FW	25	Exposed	170	
WF - P0011	HV - F056B	Ball	V304	FW	25	Exposed	170	
WF - P0012	HV - F055A	Butterfly	V500	DRN	150	Exposed	170	
WF - P0012	HV - F055B	Butterfly	V500	DRN	150	Exposed	170	
WF - P0012	HV - F055C	Butterfly	V500	DRN	150	Exposed	170	
WF - P0012	HV - F055D	Butterfly	V500	DRN	150	Exposed	170	
WF - P0012	CV - F055E	Check	V614	DRN	150	Exposed	170	
WF - P0012	HV - F055F	Butterfly	V500	DRN	150	Exposed	170	
WF - P0012	ARV - F055G	Air Release	V740	VTA	50	Exposed	170	
WF - P0012	HV - F055G	Ball	V304	VTA	50	Exposed	170	
WF - P0012	HV - F055H	Ball	V304	DRN	25	Exposed	170	
WF - P0012	CV - F981A	Check	V614	OF	150	Exposed	170	
WF - P0012	HV - F981A	Butterfly	V500	OF	150	Exposed	170	
WF - P0012	CV - F982A	Check	V614	OF	150	Exposed	170	
WF - P0012	HV - F982A	Butterfly	V500	OF	150	Exposed	170	
WF - P0012	CV - F983A	Check	V614	OF	300	Exposed	170	
WF - P0012	HV - F983A	Butterfly	V500	OF	300	Exposed	170	
WF - P0012	CV - F984A	Check	V614	OF	50	Exposed	170	
WF - P0012	HV - F984A	Butterfly	V304	OF	50	Exposed	170	
WF - P0012	ARV - F986A	Air Release	V740	VTA	50	Exposed	170	
WF - P0012	HV - F986A	Ball	V304	VTA	50	Exposed	170	
WF - P0012	HV - F986B	Ball	V304	DRN	25	Exposed	170	
WF - P0014	BPV - C100C	Back pressure valve	V718	AA	50	Exposed	170	
WF - P0014	CV - C100C	Check	V602	AA	50	Exposed	170	
WF - P0014	BPV - C100D	Back pressure valve	V718	AA	50	Exposed	170	
WF - P0014	CV - C100D	Check	V602	AA	50	Exposed	170	
WF - P0014	HV - C100E	Ball	V308	AA	50	Exposed	170	

MANUAL VALVE SCHEDULE (ALL SIZES)

P&ID Number	Tag Number	Valve Type	Valve Type Number	Commodity	Size (mm)	Valve Location	Maximum Working Pressure (kPa)	Comments/ Control Features
WF - P0014	HV - C100F	Ball	V308	AA	50	Exposed	170	
WF - P0014	HV - C100G	Ball	V308	AA	50	Exposed	170	
WF - P0014	HV - C100H	Ball	V308	AA	50	Exposed	170	
WF - P0014	HV - C100J	Ball	V308	AA	25	Exposed	170	
WF - P0014	HV - C100K	Ball	V308	AA	25	Exposed	170	
WF - P0014	HV - C100L	Ball	V331	FW	100	Exposed	170	
WF - P0014	HV - C100M	Ball	V331	FW	100	Exposed	170	
WF - P0014	CV - C110A	Check	V602	FW	50	Exposed	170	
WF - P0014	HV - C110A	Ball	V331	FW	100	Exposed	170	
WF - P0014	CV - C110B	Check	V602	FW	50	Exposed	170	
WF - P0014	HV - C110B	Ball	V331	FW	100	Exposed	170	
WF - P0014	HV - C110C	Ball	V330	FW	25	Exposed	170	
WF - P0014	HV - C110D	Ball	V330	FW	25	Exposed	170	
WF - P0014	HV - C110E	Ball	V331	FW	50	Exposed	170	
WF - P0014	HV - C110F	Ball	V331	FW	50	Exposed	170	
WF - P0014	HV - C110J	Ball	V331	FW	50	Exposed	170	
WF - P0014	HV - C110K	Ball	V331	FW	50	Exposed	170	
WF - P0014	HV - C110L	Globe	V204	FW	50	Exposed	170	
WF - P0014	HV - C110M	Globe	V204	FW	50	Exposed	170	
WF - P0014	BPV - C120A	Back pressure valve	V718	CS	50	Exposed	170	
WF - P0014	CV - C120A	Check	V602	CS	50	Exposed	170	
WF - P0014	HV - C120A	Ball	V330	CS	50	Exposed	170	
WF - P0014	BPV - C120B	Back pressure valve	V718	CS	50	Exposed	170	
WF - P0014	CV - C120B	Check	V602	CS	50	Exposed	170	
WF - P0014	HV - C120B	Ball	V330	CS	50	Exposed	170	

PIPING SPECIALTIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ASME:

.1 B16.1, Cast Iron Pipe Flanges and Flanged Fittings.

.2 B16.5, Pipe Flanges and Flanged Fittings: NPS 12 mm through NPS 600 mm.

.2 AWWA:

.1 C153/A21.53, Ductile-Iron Compact Fittings, 76 mm through 1,600 mm, for Water Service.

.2 C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

.3 C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

.4 C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.

.5 Manual M11, Steel Water Pipe—A Guide for Design and Installation.

.3 ASTM:

.1 A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.2 A276, Standard Specification for Stainless Steel Bars and Shapes.

.4 National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

.5 NSF International (NSF): NSF 61, Drinking Water System Components—Health Effects.

1.2 Submittals

.1 General:

.1 Provide coupling submittals separated in process areas as per drawing key plan with lists of quantities of each type of coupling in each area:

.1 F: Filtration area

.2 R: Residuals area

.3 O: Ozone area

.4 C: Chemical area

.5 P: DAF area

.6 A: Administration area

.7 M: Main electrical area

.8 I: Raw water pump station area

.9 Y: Yard piping chambers area

.2 Identify process area in the title of all submittal transmittals.

.2 Action Submittals: Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).

.3 Informational Submittals:

.1 Coupling Harness:

.1 Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.

.2 Weld procedure qualifications.

.3 Load proof-testing report of prototype restraint for any size coupling.

2. PRODUCTS

2.1 General

.1 Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

.2 Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

2.2 Connectors

.1 Flexible Metal Hose Connector:

.1 Type: Close pitch, annular corrugated with single braided jacket.

.2 Material: Bronze.

.3 End Connections: Female copper solder joint.

.4 Minimum Burst Pressure: 3,500 kPa at 21°C.

.5 Length: Minimum manufacturer recommendation for vibration isolation.

.6 Acceptable Manufacturers:

.1 Senior Flexonics.

.2 Anamet Industrial, Inc.

.3 Unisource Manufacturing, Inc.

.4 Proco Products, Inc.

2.3 Couplings

.1 General:

.1 Coupling linings for use in potable water systems shall be in conformance with NSF 61.

.2 Couplings shall be rated for working pressure not less than indicated in Piping Schedule, Section 15200-00S, for the service and not less than 1,035 kPa.

.3 Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

.4 Restrained Couplings: Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11, and restrained with retainer bar or ring welded to pipe end, or as shown on Drawings.

.5 Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

.2 Flexible Sleeve Type Coupling:

.1 Acceptable Manufacturers:

.1 Steel Pipe:

.1 Dresser Piping Specialties; Style 38.

.2 Smith-Blair, Inc.; Style 411.

.2 Ductile Iron Pipe:

.1 Dresser Piping Specialties; Style 253.

.2 Smith-Blair, Inc.; Style 411.

.3 Bolted Split Sleeve Type Coupling:

.1 Steel Pipe: Victaulic Depend-O-Lok, AWWA C221, EPDM elastomer, epoxy coated steel or 316 stainless steel wetted parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.

.2 Stainless Steel Air Pipe: Victaulic AirMaster Depend-O-Lok, AWWA C606, EPDM elastomer, 316 stainless steel parts, restrained (FxF) or non-restrained coupling (FxE or ExE) as indicated on Drawings.

.4 Transition Coupling for Steel Pipe:

.1 Acceptable Manufacturers:

.1 Dresser Piping Specialties; Style 162.

.2 Smith-Blair, Inc.; Style 413.

.5 Flanged Coupling Adapter:

.1 Acceptable Manufacturers:

.1 Steel Pipe:

.1 Dresser Piping Specialties; Style 128.

.2 Smith-Blair, Inc.; Style 913.

.2 Ductile Iron Pipe:

.1 Dresser Piping Specialties; Style 128.

.2 Smith-Blair, Inc.; Style 912.

.6 Restrained Flange Adapter:

.1 Pressure Rating:

.1 Minimum Working Pressure Rating: Not less than 1,035 kPa.

.2 Safety Factor: Not less than two times working pressure and shall be supported by manufacturer's proof testing.

.2 Thrust Restraint:

.1 Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.

.2 Products employing set screws that bear directly on pipe will not be acceptable.

.3 Acceptable Manufacturers:

.1 EBAA Iron Sales Co.; Mega-Flange, Victaulic Depend-O-Lok restrained FxF.

.7 Restrained Dismantling Joints:

.1 Pressure Rating:

.1 Minimum working pressure rating shall not be less than rating of the connecting flange.

.2 Proof testing shall conform to requirements of AWWA C219 for bolted couplings.

.2 Acceptable Manufacturers:

.1 Dresser Piping Specialties; Style 131.

.2 Viking Johnson.

.3 Victaulic, Style 44

2.4 Expansion Joints

.1 Elastomer Bellows:

.1 Type: Reinforced molded wide arch.

.2 End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.

.3 Washers: Over retaining rings to help provide leak-proof joint under test pressure.

.4 Thrust Protection: Control rods to protect the bellows from overextension.

.5 Bellows Arch Lining: Buna-N, nitrile, or butyl.

.6 Rated Temperature: 250^{o}C.

.7 Rated Deflection and Pressure:

.1 Lateral Deflection: 19 mm, minimum.

.2 Burst Pressure: Four times the working pressure.

.3 Compression deflection and minimum working pressure as follows:

Size (mm)	Deflection (mm)	Pressure (kPa)
65 to 300	26.9	1,035
350	41.9	900
400 to 500	41.9	750

.8 Acceptable Manufacturers:

.1 General Rubber Corp.; Style 1015 Maxijoint**.**

.2 Mercer; Flexmore Style 450.

.3 Goodall Rubber Co.; Specification E-711.

.4 Unisource Manufacturing, Inc.; Series 1500.

.5 Proco Products, Inc.; Series 251.

.2 Teflon Bellows:

.1 Type: Three convolutions, with metal reinforcing bands.

.2 Flanges: Ductile iron, drilled 1,035 kPa ASME B16.5 standard.

.3 Working Pressure Rating: 700 kPa, minimum, at 49°C.

.4 Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.

.5 Acceptable Manufacturers:

.1 Garlock; Style 215.

.2 Resistoflex; No. R6905.

.3 Unisource Manufacturing, Inc.; Style 113.

.4 Proco Products, Inc; Series 443.

.3 Metal Bellows for Compressor Pressurized Air Piping (PA) and Air Scour Piping (AS):

.1 Type: Single-ply, annular corrugated metal bellows with limit rods. Circumferential convolution welds not permitted.

.2 Material: Type 316 stainless steel.

.3 End Connections: ASME 150-pound carbon steel flanges.

.4 Minimum Design Working Pressure: 345 kPa at 200°C.

.5 Length: Minimum of twelveconvolutions and minimum manufacturer recommendation for vibration isolation.

.6 Rated minimum deflections:

.1 Axial: 50 mm.

.2 Lateral: 15 mm.

.3 Angular: 10 degrees.

.7 Acceptable Manufacturers:

.1 Hyspan Precision Products, Inc.; Series 1500.

.2 Pathway Bellows, Inc.; Style CT.

.3 Senior Flexonics; Style MCB.

.4 Copper Pipe Expansion Compensator:

.1 Material: Stainless steel bellows with female copper solder joint ends.

.2 Working Pressure Rating: 1200 kPa, minimum.

.3 Accessories: Anti-torque device to protect bellows.

.4 Acceptable Manufacturers:

.1 Senior Flexonics; Model HB.

.2 Hyspan; Model 8510.

.3 Unisource Manufacturing, Inc.; Style EC-FFS.

.5 Galvanized and Black Steel Pipe Expansion Compensator:

.1 Material: Carbon steel with stainless steel bellows

.2 Working Pressure Rating: 1200 kPa, minimum.

.3 Accessories: Anti-torque device to protect bellows.

.4 Acceptable Manufacturers:

.1 Senior Flexonics; Model H.

.2 Hyspan; Model 8503.

.3 Unisource Manufacturing, Inc.; Style EC-MMT.

.6 Flexible Metal Hose:

.1 Type: Close pitch, annular corrugated with single braided jacket.

.2 Material: Stainless steel, ASTM A276, Type 321.

.3 End Connections:

.1 75 mm and Larger: Shop fabricated flanged ends to match mating flanges.

.2 65 mm and Smaller: Screwed ends with one union end.

.4 Minimum Burst Pressure: 4150 kPa at 21°C for 300 mm and smaller.

.5 Length: Provide hose live-length equal to lengths shown on Drawings.

.6 Manufacturer:

.1 Senior Flexonics; Series 401M.

.2 Anamet Industrial, Inc.; BWC21-1.

2.5 Service Saddles

.1 Double-Strap Iron:

.1 Pressure Rating: Capable of withstanding 1,035 kPa internal pressure without leakage or over stressing.

.2 Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

.3 Taps: Iron pipe threads.

.4 Materials:

.1 Body: Malleable or ductile iron.

.2 Straps: Galvanized steel.

.3 Hex Nuts and Washers: Steel.

.5 Seal: Rubber.

.1 Acceptable Manufacturers:

.2 Smith-Blair; Series 313 or 366.

.3 Dresser; Style 91.

.4 Nylon-Coated Iron:

.6 Pressure Rating: Capable of withstanding 1035 kPa internal pressure without leakage or over stressing.

.7 Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.

.8 Materials:

.1 Body: Nylon-coated iron.

.2 Seal: Buna-N.

.3 Clamps and Nuts: Stainless steel.

.9 Manufacturer: Smith-Blair; Style 315 or 317.

2.6 Modular Mechanical Seal:

.1 Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.

.2 Fabrication:

.1 Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.

.2 Pressure plates shall be reinforced nylon polymer.

.3 Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.

.3 Manufacturer: Thunderline Corp., Link-Seal Division.

3. EXECUTION

3.1 General

.1 Provide accessibility to piping specialties for control and maintenance.

3.2 Piping Flexibility Provisions

.1 General:

.1 Thrust restraint shall be provided as specified in Section 15200-000, Process Piping.

.2 Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

.2 Flexible Joints at Concrete Backfill or Encasement: Install within 450 mm or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

.3 Flexible Joints at Concrete Structures:

.1 Install 450 mm or less from face of structures; joint may be flush with face.

.2 Install a second flexible joint, whether or not shown:

.1 Pipe Diameter 450 mm and Smaller: Within 450 mm of first joint.

.2 Pipe Diameter Larger than 450 mm: Within one pipe diameter of first joint.

.3 Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes.

.4 Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

.5 Expansion Joints:

.1 Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.

.2 Nonmetallic Pipe: Teflon bellows expansion joint.

.3 Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.

.4 Air and Water Service above 49^{o}C: Metal bellows expansion joint.

.5 Pipe Run Offset: Flexible metal hose.

3.3 Service Saddles

.1 Ferrous Metal Piping (except stainless steel): Double-strap iron.

.2 Plastic Piping: Nylon-coated iron.

3.4 Couplings

.1 General:

.1 Install in accordance with manufacturer's written instructions.

.2 Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.

.3 Application:

.1 Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.

.2 Concrete Encased Couplings: Flexible coupling.

3.5 Flexible Pipe Connections to Equipment

.1 Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

.2 Product Applications Unless Shown Otherwise:

.1 Nonmetallic Piping: Teflon bellows connector.

.2 Copper Piping: Flexible metal hose connector.

.3 Compressor Discharge: Metal bellows connector.

.4 Blower Suction and Discharge: Elastomer bellows connector (Vendor Package).

.5 All Other Piping: Elastomer bellows connector.

.3 Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

END OF SECTION

PLUMBING FIXTURES

1. GENERAL

1.1 Scope of Work

.1 Supply and install plumbing fixtures.

1.2 References

.1 The following is a list of standards which may be referenced in this Section:

.1 Canadian Gas Association (CGA).

.2 ASME

.3 CSA

.4 Code Guide 302 and Glossary of Industry Terms

.5 Underwriters Laboratories of Canada (ULC)

.6 Underwriters Laboratories (UL)

.7 American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.

.8 Plumbing and Drainage Institute (PDI):

.1 Code Guide 302 and Glossary of Industry Terms.

.2 WH-201, Water Hammer Arrester Standard.

1.3 Submittals

.1 Action Submittals:

.1 Shop Drawings: catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.4 Regulatory Requirements

.1 Comply with the Plumbing Code and the requirements of provincial and local authorities having jurisdiction.

2. PRODUCTS

2.1 General

.1 Fixture Trim: supply and install plumbing fixture trim where applicable on fixtures.

.2 Plumbing Fixtures: indicated by fixture number as shown on Drawings.

.3 Drainage Products: indicated by fixture number as shown on Drawings.

.4 Plumbing Specialties: indicated by fixture number as shown on Drawings.

.5 Exposed fixture connections and piping shall be polished chrome-plated.

2.2 Fixture Trim:

.1 Supply Stop:

.1 Flexible supply with heavy cast brass, loose key, 12 mm IPS by 10 mm OD tubing angle stop to wall with canopy flange; chrome-plated finish.

.2 Provide stop with stuffing box.

.3 Acceptable Manufacturers:

.1 McGuire Manufacturing Company, Inc.

.2 American Standard

.3 Kohler

.2 Trap:

.1 Chrome-plated, 1.4 mm thick (17-gauge), semicast P-trap with compression ring cast brass waste and vent connection and cleanout.

.2 40 mm for lavatories and drinking fountains.

.3 40 mm for sinks.

.4 Acceptable Manufacturers:

.1 McGuire Manufacturing Company, Inc.

.2 American Standard

.3 Kohler

2.3 Water Coolers

.1 EWC-1, Electric Water Cooler

.1 Barrier Free Design

.2 Finish: Steel baked enamel cabinet, satin finish stainless steel receptor, chrome-plated bubbler.

.3 Valve: Front and side self-closing push bar with automatic stream regulation.

.4 Trim: Screwdriver stop, strainer, and P-trap with cleanout.

.5 Cooler: NonCFC, air-cooled.

.6 Acceptable Manufacturers:

.1 Haws; Model HWBFA8 Fixture with Model 6700.4 wall bracket with Model 6800 carrier.

.2 Elkay

.3 Sunroc

2.4 Sinks and Lavatories

.1 L-1, Lavatory (Counter Set, Oval):

.1 Fixture: 521 mm by 445 mm, vitreous china, self-rimming.

.2 American Standard Companies, Inc., Aqualyn, Model 0476.028; Kohler; Crane.

.3 Faucet: Chicago Faucet Co., Model 2200 with 0.03 L/s flow restricter; American Standard.

.4 Trim: McGuire H165LKN3RB 10 mm supply stop with loose key, McGuire 8872C-17T, 1.4 mm thick (17-gauge) chrome-plated cast brass P-trap.

.5 Insulation: McGuire Manufacturing Company, Inc.; Prowrap antimicrobial polyvinyl chloride (PVC) resin seamless insulation for trap, tailpiece, and hot and cold water supply piping.

.6 Strainer: McGuire Manufacturing Company, Inc.; Model 155A chrome-plated grid strainer with tailpiece.

.2 L-2, Lavatory (Wall Hung Type, Stainless Steel):

.1 Fixture: 469 mm by 483 mm, 18-gauge Type 304 stainless steel, seamless welded construction with integral backsplash and apron, underside sound deadened, wall clip

with integral flange, three-hole punched on 100 mm centers for faucet. Aristaline; Model WHB1819.

.2 Faucet: Chicago Faucet Co., Model 2200 with 0.03 L/s flow restricter; American Standard.

.3 Trim: McGuire H165LKN3RB 10 mm supply stop with loose key, McGuire 8872C-17T 17-gauge, chrome-plated cast brass P-trap.

.4 Strainer: McGuire Manufacturing Company, Inc.; Model 155A chrome-plated grid strainer with tailpiece.

.5 Carrier: Smith, Series 0800-M2P.

.3 MS-1, Mop Sink (Floor Mounted):

.1 Fixture: Stern-Williams Co. Inc.; Model HL-2100-BP; Molded stone, 900 mm by 600 mm by 300 mm deep with stainless steel bumper guard, back panels and chrome-plated brass drain.

.2 Faucet: Chicago Faucet Co., Model 897 with hose threads, vacuum breaker, and rod support. Faucet mounted 900 mm above finish floor.

.3 Accessories: Stern-Williams Co. Inc.; T-35 hose and T-40 stainless steel mop hanger.

.4 SK-1, Sink (Counter, Stainless Steel, Single Compartment):

.1 Fixture: 550 mm by 550 mm by 262 mm deep, 18-gauge, Type 304 stainless steel, 3-hole punch, self-rimming, undercoated, ledge-type. Kindred “Steel Queen” QSL 2020-10.

.2 Faucet: Chicago Faucet Co., Model 2300-8 single handle with 200 mm cover plate; American Standard.

.3 Trim: 40 mm OD, 17-gauge chrome-plated cast tailpiece and cast brass P-trap with cleanout, and 12 mm wall supply stop with loose key.

.4 Strainer: Just Mfg. Co.; Model J-35, stainless steel crumb-type.

.5 SK-2, Sample Sink (Single Compartment, Free Standing):

.1 Fixture: 686 mm by 686 mm by 350 mm deep, 14-gauge, Type 304 stainless steel, 200 mm backsplash, adjustable stainless steel tubular legs. Aristalline SL2424-5.

.2 Faucet: Short spout with vacuum breaker, 20 mm hose thread outlet, pail hook, H supply arms, 100 mm to 215 mm adjustable centers, lever handles. Faucet mounted on backsplash. Chicago Faucet Co., Model 305-VB; American Standard.

.3 Trim: 40 mm OD, 17-gauge chrome-plated flat strainer, tailpiece, and cast brass P-trap with cleanout, and 12 mm wall supply stop with loose key. Elkay Mfg. Co.; Model LK-18.

.6 Acceptable Manufacturers:

.1 Faucet Fittings:

.1 Chicago

.2 American Standard

.2 Stainless Steel Sinks:

.1 Elkay

.2 Aristaline

.3 Lavatories:

.1 Chicago

.2 American Standard

.3 Symmons

.4 Mop Sinks:

.1 Stern Williams

.2 Fiat Products Inc.

2.5 Showers

.1 SH, Shower (Trim Only)

.1 Barrier free design.

.2 Showerhead: Sloan Valve Co.; Model AC-11-B-2.5, with 0.16 L/s flow restricter.

.3 Hand Spray: 0.16 L/s flow restricter, 1,500 mm flexible stainless steel hose with in-line vacuum breaker, quick disconnect, and 600 mm chrome-plated glide bar.

.4 Mixing Valve: Powers Process Control; Model Chicago Faucets 2500 VOC-B30-V-QD-5001-4158, thermostatic and pressure balancing-type.

.5 Trim: Inlet strainer, check, integral stop, temperature limit stop, 2 wall hooks, and diverter valve.

.6 Trim: Inlet strainer, check, integral stop, temperature limit stop.

2.6 Water Closets and Urinals

.1 WC, Water Closet (Flush Valve, Wall-Hung Type, Barrier Free Design):

.1 Fixture: Vitreous china, siphon jet action, top spud, elongated bowl, mounted for handicap access with flush valve handle pointed to side of stall enclosure.

.1 Acceptable Manufacturers:

.1 American Standard Companies, Inc., Afwall EL 1.6, Model 2257.103

.2 Kohler

.3 Crane

.2 Trim: Sloan Valve Co.; Royal, Model 111 RC; flush valve, 6 L per flush.

.3 Seat: White with open front, with cover.

.1 Acceptable Manufacturers:

.1 Centoco 820 STS

.2 Bemis

.3 Olsonite

.4 Carrier: Jay R. Smith Mfg. Co.; Model 200/400, commercial type.

.2 UR, Urinal (Flush Valve, Wall-Hung Type):

.1 Fixture: Vitreous china, siphon jet action with flushing rim, top spud.

.1 Acceptable Manufacturers:

.1 American Standard Companies, Inc., Allbrook 1.0, Model 6541.13203

.2 Kohler

.3 Crane

.2 Trim: Sloan Valve Co.; Royal, Model 186-1, flush valve, 4 L per flush.

.3 Carrier: Jay R. Smith Mfg. Co.; Figure 0637, commercial floor-mounted type.

2.7 Safety Equipment:

.1 EEW, Emergency Eyewash (Deck-Mounted):

.1 Eyewash: Polished dual chrome-plated brass heads, swing-away design and automatic stream control.

.2 Valve: Stay-open, polished chrome-plated brass ball valve.

.3 Acceptable Manufacturer:

.1 Haws; Model 7612

.2 Western

.2 ES, Safety Shower/Eyewash Combination:

.1 Shower: ABS plastic deluge.

.2 Eyewash: Stainless steel bowl with aerated eye/face wash.

.3 Valve: Stay open.

.4 Support: Freestanding, 32 mm galvanized pipe standard, stanchion, and floor flange.

.5 Alarms: Magnetically operated proximity switches.

.6 Acceptable Manufacturers:

.1 Haws; Model 8346

.2 Western

.3 TV-1, Tempering Valve:

.1 Materials: Maximum flowrate 40 GPM.

.2 Inlet and Outlet: 32 mm IPS.

.3 Max Inlet Pressure: 862 KPG.

.4 Max Inlet Temperature: 82°C.

.5 Outlet Temperature: 82°C.

.6 Constructed of bronze, brass, copper, and stainless steel.

.7 Acceptable Manufacturers:

.1 Haws; Model 9202

.2 Western

.4 Flow Switch for Safety Shower:

.1 General

.1 Function: Sense fluid flow in the pipeline and switch a set of contacts when the flow is positive.

.2 Type: Paddle flow sensor with magnetically coupled switch.

.3 Parts: Unitized assembly by paddle type flow sensor and switch.

.2 Performance

.1 Actuating Flow rate: 0.25 L/s

.2 Maximum Temperature operating: 105°C

.3 Maximum Pressure Rating: 1724 kPa

.3 Process Connections: A 32 mm brass tee

.4 Signal Interface

.1 Output: Single-pole, double-throw (SPDT) switch

.2 Contact: 120 VAC, 5 amps resistive, continuous

.5 Element: Paddle type, size to suit 32 mm pipe, stainless steel wetted parts.

.6 Lower Housing: Brass

.7 Manufacturer

.1 W. A. Anderson: Model V6

.2 MacDonnell

2.8 Cleanouts

.1 CO, Floor Cleanout (Finished Areas):

.1 Service: floor drainage system – tiled floor

.2 Material: tapered thread, bronze plug with round adjustable scoriated secured nickel bronze top

.3 Manufacturer and Product: Zurn Model ZN1400-NH-HD or Jay R. Smith Mfg. Co.; Model 4103S

.2 CO, Floor Cleanout (Unfinished Areas):

.1 Service: floor drainage system – exposed concrete

.2 Material: tapered thread, bronze plug with round adjustable scoriated secured cast iron top

.3 Manufacturer and Product: Zurn Model Z-1406 or Jay R. Smith Mfg. Co.; Model 4243S

.3 WCO, Wall Cleanout:

.1 Material: Stainless steel cover and screw.

.2 Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 4472.

.4 Acceptable Manufacturers

.1 Smith

.2 Zurn

.3 Watts

2.9 Floor Drains

.1 FD-1, Floor Drain (Unfinished Areas, General Drainage):

.1 Materials: Dura-coated cast iron body and grate.

.2 305 mm round grate, sediment bucket

.3 Manufacturer and Product: Zurn Model Z415N-P

.2 FD-2, Hub Drain

.1 Coated cast iron reducing hub adapter with standard cast iron hub.

.2 Hub: Two pipe sizes larger than outlet.

.3 Manufacturer and Product: Zurn Model Z-415-S-P

.3 FD-3, Floor Drain with Funnel:

.1 Materials: cast iron body and nickel bronze grate

.2 Option: oval funnel

.3 Manufacturers: Zurn ZN415-BF-P or Jay R. Smith Mfg. Co., Model 3510 F19-B-P.

.4 FD-4, Floor Drain (Gutter Drain):

.1 Material: Dura-Coated cast iron body with bottom 50 mm outlet and polished secured nickel bronze grate, 254 mm by 60 mm.

.2 Manufacturer and Product: Zurn; Model Z573

.5 FD-5, Floor Drain (Gutter Drain):

.1 Materials: rectangular Dura-coated cast iron body and grate, bottom outlet, 318 mm by 143mm grate.

.2 Manufacturer and Product: Zurn; Model Z575

.6 FD-6, Floor Drain (Ozone Areas):

.1 Materials: 316 stainless steel body and 200 mm strainer with trap primer connection

.2 Manufacturer and Product: Zurn; Model ZM1726

.7 FD-7, Funnel Floor Drain (Fabricate Funnel):

.1 Materials: Schedule 10 steel, hot dip galvanized after fabrication. See standard details.

.8 FD-8, Floor Drain (Finished Areas):

.1 Materials: Dura-coated cast iron body, 134 mm round adjustable nickel bronze strainer, membrane clamp, trap primer connection.

.2 Manufacturer and Product: Zurn Model Z415B-P

.9 Floor Drain Traps:

.1 Supply and install Dura-coated cast iron traps with floor drain fixtures, complete with trap primer connection, as required, Zurn Z1000.

.2 Provide 316 stainless steel traps for type FD-6 stainless steel floor drains.

.10 Acceptable Manufacturers:

.1 Smith

.2 Zurn

.3 Watts

2.10 Roof Drains

.1 RD-1, Roof Drain:

.1 Materials: Cast iron body with combined flashing clamp and gravel stop, and aluminum dome.

.2 Options: Extension collar, sump receiver, underdeck clamp.

.3 Manufacturer and Product: Jay R. Smith Mfg. Co.; Model 1010Y-E-R-C.

.2 RD-2, Storm Drain/Floor Drain (inside HVAC plenums):

.1 Materials: Dura-coated cast iron body and grate.

.2 305 mm round grate, sediment bucket

.3 Manufacturer and Product: Zurn Model Z415N-P

.3 Acceptable Manufacturers:

.1 Smith

.2 Zurn

.3 Watts

2.11 Sediment Interceptor

.1 Coated fabricated steel sand and sediment separator, acid resistant, four compartments, 1200 L capacity, 100 mm inlet and outlet connections, 50 mm vent connection on each compartment, heavy duty scoriated non-skid gasketed removable covers.

.2 Acceptable Manufacturers:

.1 Zurn model Z-1187, size 300

.2 Smith

2.12 Specialties:

.1 HB-1, HB-2, HB-4, Hose Bibb:

.1 Angle pattern hose valve, Class 150, all bronze, screwed ends, inside screw, rising stem TFE disc, outlet of cast brass NHT-by-NPT male-by-male nipple adapter with hexagonal wrench feature, brass cap with chain.

.2 Sizes:

.1 HB-1: 25 mm

.1 Provide vacuum breaker.

.2 Manufacturer and Product:

.1 Crane Co.; Cat. No. 17TF.

.2 Nibco; Catalog No. T-335-Y.

.2 HB-2, HB-4: 65 mm

.1 Manufacturer and Product:

.1 Nibco; Catalog No. T-335-Y.

.2 National Fire Equipment No. A55

.2 HB-3, Hose Bibb:

.1 Material: 65 mm bronze wall hydrant completed with escutcheon plate, adaptor, cap and chain. Provide 13 mm ball drip valve, brass ball, 1200 kPa working pressure, UL Listed.

.2 Acceptable Manufacturers:

.1 National Fire Equipment; Model 231.

.3 Shock Arresters:

.1 Materials: ASSE 1010 certified, Type L copper tube, piston with 2 lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.

.2 Acceptable Manufacturers:

.1 Sioux Chief Mfg. Co., Inc.; Series 650 and 660

.2 Smith

.3 Precision Plumbing Products

.4 TPD-1, Trap Priming Device:

.1 Materials: Cast bronze, line pressure drop activated, anti-siphon port, 12 mm connection.

.2 Acceptable Manufacturers:

.1 Precision Plumbing Products, Inc.; Model P1-500 trap priming valve and Model DU-4, distribution unit

.2 Smith

.5 TPD, Automatic Trap Priming System:

.1 Materials: Preset 24-hour clock, manual override switch, solenoid valve, 20 mm connection, calibrated water distribution manifold, water hammer arrestor, and steel cabinet.

.2 Power: 120 V, single-phase.

.3 Acceptable Manufacturers:

.1 Precision Plumbing Products, Inc.; Model PT

.2 Smith

.6 Pressure/Temperature Relief Valve:

.1 Materials: ASME/AGA rated, bronze body construction, vacuum relief valve vent in drain, backup emergency safety fuse plug, tamper-resistant bonnet screws, test lever, short thermostat, and automatic reseating.

.2 Acceptable Manufacturers:

.1 Watts Industries, Inc.; Series 40

.2 Cash-Acme

.3 Kunkle Valve

.7 Pressure Gauge:

.1 Materials: 90 mm gauge size, 0 to 1100 kPa range, steel case, glass crystal, brass movement, and 8.5 mm NPT lower connection.

.2 Acceptable Manufacturers:

.1 Ashcroft Dresser Instrument Division, Dresser Industries, Inc.; Type 1008

.2 Marsh

.3 Marshalltown

.8 Thermometer:

.1 Materials: Adjustable angle, bi-metal type, 114 mm dial, 0 to 85°C range, 90 mm aluminum stem, and separate NPT brass thermowell.

.2 Acceptable Manufacturers:

.1 H.O. Trerice Co.; Model 80742

.2 Weksler

.9 Flow Switch for Pumps:

.1 General

.1 Function: Sense fluid flow in the pipeline and switch a set of contacts when the flow is positive.

.2 Type: Paddle flow sensor with magnetically coupled switch.

.3 Parts: Unitized assembly by paddle type flow sensor and switch.

.2 Performance

.1 Actuating Flow rate: 0.75 L/s

.2 Maximum Temperature operating: 135°C

.3 Maximum Pressure Rating: 1724 kPa

.3 Process Connections: A 40 mm threadolet

.4 Signal Interface

.1 Output: SPDT switch

.2 Contact: 120 VAC, 5 amps resistive, continuous

.5 Element: Paddle type, size to suit 100 mm pipe, stainless steel wetted parts.

.6 Lower Housing: Stainless steel

.7 Manufacturer

.1 W. A. Anderson: Model V4

.2 MacDonnell

3. EXECUTION

3.1 Preparation

.1 Drawings do not attempt to show exact details of fixtures. Where diagrams show fixture locations, Contractor is cautioned that these diagrams must not be used for obtaining material quantities. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Contract Administrator for review before proceeding with the Work.

3.2 Installation

.1 Fixture Trim: install fixture trim where applicable on fixtures.

.2 Plumbing Fixtures, Mounting Heights:

.1 Standard rough-in catalogued heights, unless shown otherwise on Drawings.

.2 Caulk fixtures in contact with finished walls with waterproof, white, nonhardening silicone sealant which will not crack, shrink, or change colour with age, GE Silicones or approved equal.

.3 Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.

.4 Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.

.5 Safety Equipment:

.1 System Shutoff Valves:

.1 Shutoff valves shall give visual indication of position (open or closed).

.2 Shutoff valves shall be lockable valves and locked in open position.

.2 Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and the City shall sign red safety signoff tag. Requirements are as follows:

.1 Visually check safety shower/eyewash piping for leaks.

.2 Verify that upon operation, stay-open valves remain open.

.3 Shower heads to be between 2.1 m and 2.5 m above standing surface.

.4 Shower spray pattern, when valve is full open, shall be a minimum 500 mm in diameter at 1500 mm above standing surface.

.5 Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws, Model 9015.

.6 Minimum flow rates for safety showers shall be 2 L/s.

.7 Minimum flow rates for eyewashes shall be 0.2 L/s.

.8 Tempered water shall be temperature indicated on Drawings.

.6 Drainage Products:

.1 Floor Drains: set top flush with floor. Supply and install membrane clamps where required.

.2 Cleanouts: install where shown or required for purposes intended. Set cover flush with finished floor.

.7 Plumbing Specialties:

.1 Hose Bibbs and Wall Hydrants: Mount 600 mm above finished floor or grade, unless indicated otherwise on Drawings.

.2 Shock Arresters: Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on Drawings. Shock arresters to have access panels or to be otherwise accessible.

.3 Trap Priming Valves:

.1 Floor drain traps primed with priming valves, 12 mm copper to floor drain.

.2 Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor's rooms and as indicated on Drawings.

.3 Provide shutoff valve ahead of priming valves.

.4 Thermometers and Pressure Gauges:

.1 Arrange devices to facilitate use and observation.

.2 Install in orientation that will allow clear observation from ground level.

.3 Provide pressure gauges with block valves.

.4 Install thermometers in thermowells.

.8 Caulk penetrations of exterior walls with weatherproof sealant.

.9 Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.3 Field Quality Control

.1 Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

.2 Cover concealed or insulated work only after testing has been successfully completed.

.3 Notify Contract Administrator forty eight (48) hours prior to shower testing. Contract Administrator reserves the right to witness all tempered water and safety shower testing.

.4 Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.

.1 Shower Flow:

.1 Test with tube-type water gauge (Haws, Model 9010) and 20 L container.

.2 Container shall fill in 10 seconds or less, with a minimum 2 L/s flow.

.2 Eyewash Flow:

.1 Test with tube-type water gauge (Haws, Model 9010) and 4 L container.

.2 Container shall fill in 20 seconds or less.

.3 Contractor shall log, date, and initial inspection upon passing flow tests.

.5 Verify alarm operation both locally and systemwide. Notify security prior to test if alarm is connected systemwide.

END OF SECTION

PLUMBING EQUIPMENT

1. GENERAL

1.1 Section Includes

.1 This section specifies the supply, factory testing, delivery, and supervision of installation, testing and performance verification of plumbing equipment.

1.2 Reference Standards

.1 The following is a list of standards which may be referenced in this Section:

.1 Provincial Plumbing Code and the requirements of local authorities having jurisdiction.

.2 Canadian Gas Association (CGA).

.3 CSA/CSA Label on Fixtures and Equipment.

.4 American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.5 American Society of Mechanical Engineer's (ASME): Boiler and Pressure Vessel Code SEC VIII, D1, Rules for Construction of Pressure Vessels.

.6 ASTM:

.1 A48, Standard Specification for Gray Iron Castings.

.2 A48, Gray Iron Castings

.3 A108, Steel Bars, Carbon Cold Finishes, Standard Quality

.4 A276, Stainless Steel and Heat-Resisting Steel Bars and Shapes

.5 A532, Abrasion Resistant Cast Iron

.6 D4101, Specification for Polypropylene Injection and Extrusion Materials.

.7 AWWA:

.1 C510, Double Check Valve Backflow Prevention Assembly.

.2 C511, Reduced-Pressure Principle Backflow Prevention Assembly.

.3 C550, Protective Epoxy Interior Coatings for Valves and Hydrants.

.8 CSA:

.1 B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).

.2 B64.5, Backflow Preventers, Double Check Valve Type (DCVA).

.3 C22.1 Canadian Electrical Code (CEC), Safety Standard for Electrical Safety Installations

.9 Factory Mutual Engineering and Research Corporation (FM).

.10 National Electrical Code (NEC).

.11 National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.

.12 National Sanitation Foundation International (NSF).

.13 Underwriters Laboratories Inc. (UL).

.14 Underwriters Laboratories of Canada (ULC).

.15 Hydraulic Institute Standards, Standards of the Hydraulic Institute, 14th Edition

1.3 Design

.1 Design and select plumbing equipment specifically with high efficiency, low energy consumption and innovative technology.

.2 Provide totally enclosed fan-cooled type electric motors unless noted otherwise.

1.4 Shop Drawings

.1 Action Submittals: Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, capacity, pump curves, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 Installation instructions.

.4 Special tools.

.2 Informational Submittals:

.1 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

.2 Complete description of operation together with general arrangement and detailed drawings, wiring diagrams for power and control schematics, parts catalogues with complete list of repair and replacement parts with section drawings, illustrating the connections and the part Manufacturer's identifying numbers.

.3 Certificate of Satisfactory Installation, Form 102, as indicated in Section 01650, Equipment Installation.

2. PRODUCTS

2.1 Submersible Centrifugal Sump Pumps

.1 Supply and install submersible pumps for sanitary pumping stations. Stations shall be either simplex or duplex type as indicated in the schedules below.

.2 General:

.1 Provide submersible non-clog pumps of the close-coupled integral, wet well submersible type.

.2 Provide submersible pumps that operate at given conditions without cavitation or damage to bearings, shaft or any other stationary or rotating parts.

.3 Provide pumps suitable for continuous or intermittent operation.

.4 Select pumps with head capacity curve continuously rising to shutoff.

.5 Provide motors that are non-overloading at any point on the pump operating curve.

.3 Pump Construction:

.1 Materials:

.1 Pump Impeller: Grey cast iron, ASTM A48 Class 35B, with hardened edges

.2 Pump Casing: Grey cast iron, ASTM A48 Class 35B

.3 Pump Shaft: AISI type 431 stainless steel, ASTM A276

.4 Discharge Elbow: Grey cast iron, ASTM A48

.2 Impeller:

.1 Semi-open, multi-vane, back swept non-clog design, capable of passing 50 mm spherical solids.

.2 Design so that impeller vanes self-clean upon each rotation.

.3 Supply impeller with heavily back swept edges, with a specific angle of distribution sufficient for handling solids, fibrous materials, heavy sludge and other matter found in wastewater.

.4 Balance impeller both statically and dynamically.

.5 Key the impeller to the shaft and secure by an impeller nut suitably restrained to prevent loosening and impeller spin off due to torque developed during operation or in the event of reverse rotation.

.3 Seals:

.1 Provide each pump with a tandem mechanical shaft seal system consisting of two, totally independent seal assemblies operating in an oil reservoir.

.2 Protect the seal spring from exposure to the mixed media to avoid seal spring jamming or failure.

.3 Provide seals that do not require regular maintenance or adjustment.

.4 Provide seal failure warning device on lower seal.

.4 Electrical:

.1 Submersible, oil resistant, UL and CSA approved electrical power cord.

.2 Pumps, cables and instruments shall be suitable for Class 1, Zone 2 area classification.

.3 Design the cable entry to be an integral part of the motor housing. Epoxies, silicones, or other secondary sealing systems are not considered acceptable.

.5 Motor:

.1 Motor: Sealed, oil-filled, NEMA B design.

.2 Provide motors suitable for submerged service.

.6 Pump Bearings: Permanently grease-lubricated angular contact and ball bearings designed to withstand the stress of the service specified.

.7 Shaft:

.1 Provide rigid shaft capable of supporting the impeller and of transmitting loads without slip, vibration or undue deflection at operating loads.

.2 The use of shaft sleeves to protect a lesser grade shaft material will not be accepted.

.3 Solid Type 303 stainless steel shaft.

.4 Level Controls

.1 Provide mercury float-type, sealed, level switches, complete with waterproof submersible, oil-resistant cables, suitable for Class 1, Zone 2 area classification.

.2 Level Controls – Simplex Sump Pump Stations

.1 For simplex sump pump stations Provide monitoring of three (3) levels to control operation of the sump pump. Start the pump at a high liquid level and stop at low liquid level. In addition, provide a high/high level alarm.

.3 Level Controls – Duplex Sump Pump Stations

.1 Provide monitoring of four (4) liquid levels to control operation of the pumps. Start the lead pump at the first high liquid level. Start the lag pump at the second high liquid level. Both sump pumps will stop at the low liquid level. In addition, each sump will have a high/high level alarm.

.5 Control Panels

.1 Provide each sump station with a control panel containing all control and distribution equipment including but not limited to motor starters, transformers, switches, indicators, logic control unit, relays, and contactors, etc.

.2 Fabricated steel, NEMA 4 enclosure, door disconnect switch. CSA approval required.

.3 Provide programmable logic control (PLC) unit and relays. The level transducer is to operate in conjunction with the PLC.

.4 Control systems shall be intrinsically safe. Control systems include level switches, moisture switches, and temperature switches.

.5 Wiring and Conduit: Minimum of MTH, 600V rated, 18-gauge with 90^{o}C rating.

.6 Motor Protection: Magnetic motor starter, across-the-line type, under voltage and over voltage protection with manual reset button mounted in panel door.

.7 Provide the following components and control devices located on the front door of control panel:

.1 Panel main power disconnect switch

.2 Disconnect switch for each pump motor

.3 COMPUTER/OFF/HAND selector switch for each pump

.4 “Pump Running” status indicating light for each pump (Red lens)

.5 “Pump Stopped” status indicating light for each pump (Green lens)

.6 "Motor Temp" alarm indicating light for each pump, required only on duplex pump stations (Red lens)

.7 "Seal Leak" alarm indicating light for each pump, required only on duplex pump stations (Red lens)

.8 "Level High/High" alarm indicating light (Amber lens)

.9 "Alarm Reset" push button

.8 For duplex pump stations, provide automatic lead/lag alternation for the pumps.

.9 Provide resetable circuit breakers for panel control circuit, pump motor monitoring panel and level controls

.10 Provide motor supervision relay for each pump.

.11 Provide the following dry contacts for remote annunciation:

.1 "Level High/High" alarm

.2 "General Alarm" combined alarm of pump overload, pump motor leakage/temperature and level controller failure

.6 Sump:

.1 Cover plate: With vapour tight gasket, hinged equipment doors with drop handles, accessory mounting plates, discharge and vent pipe openings, and sealed power and control cable openings.

.2 Provide lifting chain or cable, shackle and hook, all of type 316 stainless steel. Chain length shall be long enough so that it can be tethered off at the top of the sump. Provide tethering hook.

.7 Quick Removal Guide Bar System:

.1 Supply guide bar assembly to mount the pump during operation and to guide the unit during installation and removal from service. Provide assembly with an upper, lower and intermediate (if required) bracket.

.2 Provide cast iron stationary pump discharge.

.3 Provide guide bar assembly, type 316 stainless steel.

.4 Provide pumps that automatically connect to a discharge elbow when lowered in place.

.5 Design the pump connection to form a metal-to-metal seat between the pump and the discharge connection to prevent leakage. Ensure that gaskets, O-rings or other sealing arrangements are not required to seal the discharge connection.

PLUMBING EQUIPMENT

.8 Design Standard:

.1 ITT Flygt

.9 Acceptable Manufacturers:

.1 ITT Flygt

.2 Myers

.3 Hydromatic

.10 Lifting Davit:

.1 When indicated in the schedule, provide a portable floor-mounted lifting davit and chain hoist for removal of sump pumps. For duplex pump stations, davit shall be capable of swiveling so that it will line up with both pumps.

.2 Acceptable Manufacturers: Flygt.

.11 Sump Pump Schedule:

Tag Numbers	**P-H501A, P-H502A**
Name	Sanitary Sump – Fire Pump Room
Type	Duplex
Flow Rate, each pump	1.7 L/s
Pump Head	4.7 m
Pumped Fluid	Sewage (floor drainage)
Motor	0.37 kW
Motor Speed (rpm)	3450 rpm
Power	120V / 1 ph / 60 Hz
Motor winding thermal sensors and seal leak detection	Yes, required
Outlet connection	50 mm
Weight	TBD
Manufacturer/Model	Pentair Myers WHR5H-11
Sump Size	1.0 mL x 1.0 mW (square)
Finished Floor Elevation	234.500 m
Inlet Pipe Elevation	233.100 m
Lead Pump ON Level	233.99 m
Lag Pump ON Level	234.10 m
Pumps OFF Level	233.40 m
High Level Alarm	234.20 m
Bottom of Sump	233.100 m
Accessories	Davit and hoist required. Guide bar system not required.

.12 Sump Pump Schedule:

Tag Numbers	**P-H511A, P-H512A**
Name	Sanitary Sump – Backwash Pump Gallery
Type	Duplex
Flow Rate, each pump	6.31 L/s
Pump Head	10.3 m
Pumped Fluid	Sewage
Motor	2.8 kW
Motor Speed (rpm)	3320 rpm
Power	575V / 3 ph / 60 Hz
Motor winding thermal sensors and seal leak detection	Yes, required
Outlet connection	50 mm
Weight	38 kg
Manufacturer/Model	ITT Flygt CP 3057 63-254-00-8160
Sump Size	1.5 mL x 1.5 mW (square)
Finished Floor Elevation	230.250 m
Inlet Pipe Elevation	229.150 m
Lead Pump ON Level	229.00 m
Lag Pump ON Level	229.20 m
Pumps OFF Level	228.00 m
High Level Alarm	229.30 m
Bottom of Sump	227.700 m
Accessories	Davit and hoist required. Guide bar system required.

.13 Sump Pump Schedule:

Tag Numbers	**P-H531A, P-H532A**
Name	Sanitary Sump - Administration Area
Type	Duplex
Flow Rate, each pump	10.9 L/s
Pump Head	15.4 m
Pumped Fluid	Sewage
Motor	5.6 kW
Motor Speed (rpm)	1740 rpm
Power	575V / 3 ph / 60 Hz
Motor winding thermal sensors and seal leak detection	Yes, required
Outlet connection	100 mm flange
Weight	147 kg
Manufacturer/Model	ITT Flygt CP3127 63-485-00-2202
Sump Size	2.0 mL x 2.0 mW (square)
Finished Floor Elevation	233.17 m
Inlet Pipe Elevation	231.900 m
Lead Pump ON Level	231.68 m
Lag Pump ON Level	231.80 m
Pumps OFF Level	230.37 m
High Level Alarm	231.90 m
Bottom of Sump	230.070 m
Accessories	Davit and hoist required. Guide bar system required.

.14 Sump Pump Schedule:

Tag Numbers	**P-H521A**
Name	Sanitary Sump – Elevator Pit
Type	Simplex
Flow Rate, each pump	1.9 L/s
Pump Head	4.0 m
Pumped Fluid	Sewage (floor drainage)
Motor	0.24 kW
Motor Speed (rpm)	1550 rpm
Power	120V / 1 ph / 60 Hz
Motor winding thermal sensors and seal leak detection	Not required
Outlet connection	40 mm NPT
Weight	TBD
Manufacturer/Model	Pentair Meyers MDC33
Sump Size	1.0 mL x 1.0 mW (square)
Finished Floor Elevation	233.170 m
Inlet Pipe Elevation	232.960 m
Pump ON Level	232.61 m
Pump OFF Level	232.27 m
High Level Alarm	232.91 m
Bottom of Sump	231.970 m
Accessories	Davit and hoist required. Guide bar system not required.

2.2 Water Booster Pump Systems – General (Tag Numbers: P-H701A, P-H702A, P-H703A)

.1 General:

.1 Provide packaged booster pump systems as indicated in the schedules below:

.2 Packages shall include pumps, controls, control panel, piping, valves, relief valves and appurtenances, factory assembled, skid mounted, prewired, and tested.

.3 Pumps: vertical inline, direct drive, complete with shaft coupling and coupling guard.

.4 Pumps shall be fitted with Manufacturer's standard mechanical seal suitable for potable water service, complete with seal flush piping.

.2 Pump Materials

.1 Impeller: Grey cast iron, ASTM A48 Class 35B, with hardened edges

.2 Casing: Grey cast iron, ASTM A48 Class 35B

.3 Shaft: AISI type 431 stainless steel, ASTM A276

.3 Piping:

.1 Stainless steel piping and fittings in accordance with Section 15200-08.

.2 Fabrication and installation in accordance with Section 15100-00, Plumbing Piping.

.4 Valves:

.1 Isolation Valves: Full port ball or butterfly type in accordance with Section 15100-00 – Plumbing Piping.

.2 Check Valves: Non-slam type in accordance with Section 15100-00 – Plumbing Piping.

.5 Pressure Gauges:

.1 Provide one gauge on the discharge of each pump and a common gauge on the suction piping.

.2 Provide in accordance with Section 15100-00 – Plumbing Piping.

.6 Pressure Relief Valves

.1 Tag Numbers: PRV-H701A, PRV-H703A

.2 Designed and sized to relieve minimum pump flow back to the pump suction to prevent pump overheating and unstable operation, suitable for continuous operation.

.3 50 mm NPT connections, bronze body, 316 stainless steel trim, pilot operated.

.4 Set pressure: 750 kPa(g).

.5 Acceptable Manufacturers:

.1 Singer

.2 Cla-Val

.7 Electrical and Controls

.1 Control Panel: UL listed, NEMA 4 enclosure, single point electrical connection complete with combination magnetic full voltage starter, interlock panel door with breaker handle to prevent opening of door when the breaker is closed. Components shall have UL label. Wiring, schematics and workmanship shall comply with CSA and UL.

.2 Wiring: Minimum 600 V rated, 14 gauge with 90^{o}C rating, in accordance with CSA standards.

.3 Refer to Section 15010 – General Mechanical Provisions for motor requirements.

.4 Variable Frequency Drives (VFD): The schedules below indicate which pumps require VFDs. Provide the VFDs as part of pump packages in accordance with Section 16815 – Variable Frequency Drives.

.5 Operator Controls and Indicators:

.1 One ON/OFF/AUTO selector switch for each pump with indicating lights.

.2 One overload trip indicating light for each pump

.3 While a pump is on activate the corresponding ON indicating light.

.4 Provide discrete output for the ON status of each pump.

.6 Special Requirements – Clearwell Booster Pump (Tag Numbers: P-H701A)

.1 The pump shall be manually controlled.

.2 Provide terminals for the following interconnections with the WTP control system. Wiring will be by Division 17.

.1 Remote automatic start/stop signal

.2 Remote manual start/stop signal

.3 Running status

.4 Fault/Trouble

.7 Special Requirements – Potable Water Booster Pumps (Tag Numbers: P-H702A, P-H703A)

.1 Hydropneumatic Tank: Provide and install 500 L bladder type hydropneumatic tank, 1035 kPa design pressure, Armstrong model FX-500L or approved equal.

.2 Controls

.1 Provide PLC based controls and an touch screen operator interface.

.2 Provide a Lead Pump status indicator.

.3 Provide ON/OFF/AUTO buttons on the operator interface.

.4 The pump designated as Lead shall run maintaining a constant system pressure. The pump controller shall compare discharge pressure with the setpoint and adjust the pump speed to maintain the setpoint.

.5 Once the Lead pump exceeds the best operating point the Lag pump shall start following a 10 second time delay. Both pumps shall run together at the same speed with the speed varying as required to maintain the setpoint pressure.

.6 The Lag pump shall have an adjustable minimum run timer initially set for 5 minutes.

.7 When two pumps are running below the best operating point, and the Lag pump run timer has run out, the Lag pump speed shall ramp down and the pump then shuts down. The Lead pump shall continue to operate.

.8 The Lead pump shall alternate every 24 hours (adjustable) via a real time clock. The time clock will bring on the Lag pump. During the changeover both pumps will run for 5 seconds and then the first pump will shut down.

.9 If the Lead pump operates at the minimum speed for a period of 2 minutes (adjustable) the pump will shut down. The pump will restart when the system pressure drops 35 kPa below the setpoint.

.10 Provide an aquastat to monitor the pump seal chamber temperature and prevent overheating during periods of low water demand. On a high temperature condition energize a solenoid to drain water.

.3 Provide for the following interconnections with the plant control system for each pump:

.1 Inputs:

.1 Remote automatic start/stop signal

.2 System pressure (analog)

.3 Discharge pressure setpoint

.4 Remote manual start/stop signal

.5 Pump minimum speed setting

.2 Outputs:

.1 Fault/Trouble

.2 Running status for each pump

.3 Pump speed to VFD for each pump (analog)

.8 Lifting Davit:

.1 Provide a base-mounted lifting davit and hoist for removal of booster pumps and hydropneumatic tank.

.2 1000 kg capacity, spur gear hand winch, adjustable boom, ratchet style screw jack.

.3 Acceptable Manufacturers: Thern model 571.

.9 Acceptable Manufacturers:

.1 Bell & Gossett.

.2 Paco Pumps.

.3 S.A. Armstrong.

PLUMBING EQUIPMENT

.10 Booster Pump Schedule:

Tag Numbers	**P-H701A**
Name	Clearwell Booster Pump Package
Type	Simplex
Flow Rate, each pump	22.1 L/s
Pump Head	42 m
Pumped Fluid	Potable Water
Suction Pressure	138 kPa(g)
Pump Discharge Pressure	550 kPa(g)
Pump Casing Design Pressure	1035 kPa
Motor	22.4 kW
Motor Speed (rpm)	3560 rpm
Power	575V / 3 ph / 60 Hz
Pump Speed Control	Constant speed. A thermal bleed circuit is required for pump over-temperature protection.
Suction connection	150 mm, 150-lb RF flange
Discharge connection	150 mm, 150-lb RF flange
Manufacturer/Model	Armstrong Series 6712 with Series 4380, 3x3x8, vertical inline pump.

PLUMBING EQUIPMENT

.11 Booster Pump Schedule:

Tag Numbers	**P-H702A, P-H703A**
Name	Potable Water Booster Pump Package
Type	Duplex
Flow Rate, each pump	18.9 L/s
Pump Head	42 m
Pumped Fluid	Potable Water
Suction Pressure	138 kPa(g)
Package Discharge Pressure	550 kPa(g)
Pump Casing Design Pressure	1206 kPa
Motor	18.6 kW
Motor Speed (rpm)	3560 rpm
Power	575V / 3 ph / 60 Hz
Pump Speed Control	Yes, variable frequency drives required.
Suction connection on package	150 mm, 150-lb RF flange
Discharge connection on package	150 mm, 150-lb RF flange
Manufacturer/Model	Armstrong Series 6722 with Series 4380, 3x3x8, vertical inline pumps, variable Speed Booster System with a bladder type hydropneumatic tank

2.3 Backflow Preventers

.1 Reduced Pressure Backflow Preventers (65 mm through 250 mm):

.1 Description:

.1 Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013.

.2 Valve Body: Ductile or cast iron, Class 125, epoxy-coated (FDA approved).

.3 End Connections: flanged.

.4 Maximum Working Pressure: 1207 kPa (2413 kPa test).

.5 Temperature Range: 0 to 60 ^{o}C.

.6 Shutoff Valves: non-rising stem, resilient seated gate valves with bronze ball valve test cock.

.7 Inlet Strainer: cast-iron wye strainer, Class 125 flanged, fusion epoxy AWWA C550 coated, perforated stainless steel screen (1.5 mm perforations on 65 mm to 100 mm; 3 mm perforation on 150 mm to 250 mm), threaded cap plug blowout opening.

.8 Accessories: drain line air gap fitting.

.2 Tag Numbers: BFP-H704A, 100 mm.

.3 Acceptable Manufacturers:

.1 Febco - Model 860.

.2 Watts - Model 909.

.2 Reduced-Pressure Backflow Preventers (20 mm through 50 mm):

.1 Description:

.1 Regulatory Compliance: AWWA C511, CSA B64.4.

.2 Valve Body: bronze.

.3 End Connections: threaded, NPT.

.4 Maximum Working Pressure: 1207 kPa (2413 kPa test).

.5 Temperature Range: 0 to 60 ^{o}C.

.6 Shutoff Valve: full port, resilient seated, bronze ball valve with bronze ball valve test cock.

.7 Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.

.2 Accessories: drain line air gap fitting.

.3 Acceptable Manufacturers:

.1 Febco.

.2 Watts.

2.4 Backwater Valve

.1 Type-1:

.1 Flapper type backwater valve, Dura-Coated cast iron body, hub inlet and offset spigot outlet, bronze threaded cover, flapper which hangs during periods of non-operation.

.2 Acceptable Manufacturers:

.1 Zurn figure Z-1095.

.2 Type-2:

.1 Flapper type backwater valve, Dura-Coated cast iron body, hub inlet and open outlet for installation at the end of drainage line, flapper which hangs during periods of non-operation.

.2 Acceptable Manufacturers:

.1 Zurn figure Z-1091.

.3 Type-3:

.1 Flapper type backwater valve, Dura-Coated cast iron body, no-hub inlet/outlet, floor level cleanout with secured gasketed cover, adjustable housing frame and cover, backwater valve assembly.

.2 Acceptable Manufacturers:

.1 Zurn figure Z-1095-15.

2.5 Gas Water Heaters

.1 Description:

.1 Type: Automatic, gas-fired, instantaneous type with the following features:

.1 Direct vent.

.2 Sealed combustion chamber.

.3 ASME rated for 1103 kPa working pressure and 82 ^{o}C temperature.

.2 Regulatory Compliance: CGA, ASME, ASHRAE 90.1, and NSF.

.3 Tank: steel, glass-lined, 1134 kPa working pressure, 2070 kPa test pressure.

.4 Insulation: foam or fibreglass type with minimum R value per ASHRAE 90.1.

.5 Pressure/Temperature Relief Valve: ASME rated.

.6 Connections: inlet and outlet with factory-installed dielectric unions and brass drain valve with hose thread.

.7 Burner: stainless steel, 99% efficient, low NOx Premix Power burner.

.8 Vent: Direct vent through wall or roof.

.9 Controls: Electronic ignition system, adjustable electronic thermostat.

.10 Acceptable Manufacturers:

.1 Bradford White

.2 AO Smith.

.3 Ruud-Rheem

.11 Water Heater Schedule:

Tag Number	**Location**	**Heating Input (kW)**	**Recovery @ 38^{o}C Temp Rise (L/h)**	**Thermal Efficiency**	**Manufacturer/ Model**
DWH-M401	Mechanical Room No.4	58.6	1688.3	92.0%	Bradford White, EF-60T-199E
DWH-M402	Mechanical Room No.4	58.6	1688.3	92.0%	Bradford White, EF-60T-199E
DWH-M301	Mechanical Room No.3	36.6	548.9	96.0%	Bradford White, EF-60T-125E
DWH-M302	Mechanical Room No.3	36.6	548.9	96.0%	Bradford White, EF-60T-125E

PLUMBING EQUIPMENT

Tag Number	Location	Heating Input (kW)	Recovery @ 38°C Temp Rise (L/h)	Thermal Efficiency	Manufacturer/ Model
DWH-M201	Mechanical Room No.2	36.6	548.9	96.0%	Bradford White, EF-60T-125E

Notes:

1. Water heaters to be vertical configuration, 1448 high x 716 mm diameter, 227 L volume, 75 or 100 mm vent, 75 mm air intake, 38 mm water connection, 19 mm gas connection, 259 kg shipping weight.
2. Electronic ignition, 115 Vac required.

2.6 Air Compressors

.1 General

.1 Air compressor package shall consist of receiver mounted compressor(s), horizontal receiver, refrigerant type air dryer, filter, automatic drain traps, and controls.

.2 Acceptable Manufacturers:

.1 Quincy Compressor.

.2 Thomas Industries.

.2 Compressor:

.1 Number of compressors required: 2

.2 Tag Numbers: CMP-H601A, CMP-H602A

.3 Performance:

.1 Compressor capacity: 30.6 m^3/h each

.2 Motor: 3.7 kW each

.3 Maximum working pressure: 1200 kPa(g)

.4 Starting pressure: 600 kPa(g)

.5 Stopping pressure: 700 kPa(g)

.4 Two-cylinder, single stage, reciprocating, fan-air cooled.

.5 Belt drive compressor with electric motor.

.6 Mount unit on steel base attached to receiver.

.7 Belt guard.

.8 Equip with combination air intake filter silencer, discharge cushion chamber, and three additional intake filter cartridges.

.9 Unit to include internal thermal overload protection, pressure switch with unloader, and check valve with unloader port.

.3 Motor:

.1 Energy efficient, squirrel-cage type, designed, manufactured, and tested in accordance with NEMA MG 1.

.2 Totally enclosed fan-cooled enclosure (TEFC) for indoor installation.

.3 Rated continuous duty, compatible with horsepower required by driven equipment, with 1.15 service factor.

.4 Connected load shall not exceed motor nameplate horsepower rating under anticipated operating conditions.

.4 Intercooler, Aftercooler and Moisture Separator:

.1 Quantity required: two (one for each compressor).

.2 Capacity: to match compressor.

.3 Receiver mounted, suitable for maximum pressure of 1724 kPa and installed between compressor discharge and wet-air receiver.

.4 Locate moisture separator downstream of aftercooler and include automatically trapped drain.

.5 Provide solenoid valve in water supply to aftercooler to stop cooling water when compressors are off.

.5 Wet-Air Receivers:

.1 Quantity required: two (one for each compressor).

.2 Tag Numbers: PV-H601A, PV-H602A

.3 Capacity: 300 L

.4 Horizontal orientation.

.5 Maximum working pressure: 1379 kPa

.6 Welded steel tank provided with required inspection openings meeting ASME Code and bearing ASME Code stamp.

.7 Provide suitable safety valve, pressure gauge with gauge cock, automatic condensate drain valve with isolation valve, and manual blowdown valve located at low point in receiver.

.6 Dry-Air Receiver:

.1 Quantity required: one.

.2 Tag Number: PV-H605A

.3 Capacity: 300 L

.4 Vertical orientation.

.5 Maximum working pressure: 1379 kPa

.6 Welded steel tank provided with required inspection openings meeting ASME Code and bearing ASME Code stamp.

.7 Provide suitable safety valve, pressure gauge with gauge cock, manual blowdown valve located at low point in receiver, 50mm NPT air inlet and outlet connections.

.8 Provide low pressure switch with ball type isolation valve, set at 500 kPa (adjustable), 30 kPa deadband, form C contacts, brass or stainless steel body, NEMA 4 enclosure.

.7 Control System:

.1 Provide complete system for ON/OFF cyclic operation from pressure switch system.

.2 Provide automatic low oil pressure shutdown with indicating light and oil pressure gauge.

.8 Panel:

.1 NEMA 4 for indoor installation.

.2 House complete control system including disconnect switch, control power transformer, COMPUTER/OFF/HAND switch, pressure switches, relays, system pressure indicator, indicating light(s), and combination motor starter (NEMA Size 1, minimum) with overload protection, in accordance with Division 16, ELECTRICAL.

.3 Provide set of contracts for indication of unit trouble for connection to panel control system. Alarm conditions monitored shall include compressor high temperature, compressor failure and dryer high temperature.

.4 Mount in panel convenient location on receiver.

.5 Furnish control components prewired and prepiped.

.6 Provide power feed to air dryer.

.7 Power supply: 575-volts, three-phase, 60Hz

.9 Refrigerant Type Air Dryer:

.1 Quantity required: two (one for each compressor).

.2 Tag Numbers: AD-H601A, AD-H602A

.3 Capacity: 30.6 m^3/h, 3^oC dewpoint

.4 Components:

.1 Air-cooled refrigeration condenser, air-to-refrigerant, and air-to-air, tube-in-tube nonfouling heat exchangers.

.2 Include combination separator/filter capable of removing 100 percent of solid particles 3 microns in size and larger.

.3 Stainless steel separator with coalescing type filter.

.4 Equip dryer with automatic drain trap for removing collected condensate.

.5 House entire unit in 1.2 mm thick (18-gauge) steel case suitable for wall mounting.

.6 TEFC motor enclosures.

.5 Controls:

.1 Provide power ON/OFF switch, ON light and HIGH AIR TEMPERATURE warning light.

.2 Utilize hot gas bypass system to maintain constant dew point from no-load to full-load conditions.

.3 Provide fan cutout switch for stopping fans during low ambient conditions.

.4 Provide electrical system with thermal and overload protection with automatic reset.

.5 NEMA 4 enclosures.

.6 Acceptable Manufacturers:

.1 Wilkerson.

.2 ZEKS Air Drier Corporation.

.3 Zurn.

.10 Accessories:

.1 Flexible Discharge Connection: Thermal Transfer Products, Ltd.

.2 Automatic Drain Traps:

.1 Solid state, electrically operated, self-cleaning drain valves.

.2 Provide with solid state NEMA 1 panel with adjustment for both drain cycle and open period.

.3 Manufacturer: Rogers Machinery Company; Quincy Northwest Posi-Drain.

.11 Particulate Filter:

.1 Quantity required: one per compressor.

.2 Tag Numbers: AF-H603A, AF-H604A

.3 Capacity: 30.6 m3/h

.4 High flow capacity, 5-micron particulate filter, 1,050 kPa maximum supply pressure, 12 mm NPT, zinc body, quick-disconnect plastic bowl with nitrile seal, and manual drain.

.5 Acceptable Manufacturer: Wilkerson; Particulate Filter F18.

.12 Coalescing Filter:

.1 Quantity required: one per compressor.

.2 Tag Numbers: AF-H603B, AF-H604B

.3 Capacity: 30.6 m3/h

.13 Adjustable Pressure Regulator:

.1 Adjustable pressure range from 0 to 862 kPa, 2069 kPa maximum supply pressure, 12 mm NPT, zinc body with brass valve, nitrile/zinc diaphragm and stainless steel spring, and 40 mm dial face pressure gauge.

.2 Acceptable Manufacturer: Wilkerson; Regulator R18.

.14 Quick-Connect Fittings

.1 Provide quick-connect type fittings at compressed air utility stations, brass body, 12 mm (1/2-inch) female connection for air hose, automatic shutoff when no hose is connected, female NPT thread for connection to air piping system.

.2 Acceptable Manufacturer: Parker Hannifin 30 Series or approved equal.

.15 Finishes

.1 Paint equipment at factory with Manufacturer's standard machinery enamel.

3. EXECUTION

3.1 Manufacturer's Representative

.1 For pump systems and compressor systems, provide the services of a qualified technical representative for installation, testing and Performance Verification.

3.2 Installation

.1 Install, arrange, and connect equipment as shown on Drawings and in accordance with Manufacturer's recommendations.

.2 Have the Manufacturer's Representative instruct Contractor in the methods and precautions to be followed in the installation of the equipment

.3 Have the Manufacturer's Representative supervise and cooperate with the Contractor as necessary.

3.3 Factory Tests

.1 Check impeller(s), motor rating(s), and electrical connection(s) for compliance to the specifications and shop drawings.

.2 Vacuum test all pumps to establish sealing integrity, and momentarily energize to determine correct rotation and current draw (prior to immersion).

3.4 Extra Materials

.1 Provide any special tools required for the maintenance of the equipment supplied. Special tools are tools which are not normally available in mechanic's or millwright's tool kit and which are peculiar to the equipment supplied.

3.5 Field Quality Control

.1 Pump systems and air compressor system.

.1 Provide Certificate of Equipment Satisfactory Installation, Form 102, in accordance with Section 01650, Equipment Installation.

.2 Provide Certificate of Equipment Satisfactory Performance, Form 103, in accordance with Section 01650, Equipment Installation.

3.6 Training

.1 Provide training for water pumping systems and air compressor. Training of City's personnel shall be carried out as per Section 01664, Training.

.2 Training for submersible centrifugal sump pumps is not required.

3.7 Extended Warranty

.1 Gas Water Heaters: Provide 5-year Manufacturer’s warranty covering the water tank.

END OF SECTION

HEAT GENERATION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 CAN/CSA B149.1 Natural Gas and Propane Installation Code.

.2 AMCA: Bulletin 300.

.3 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 90, Energy Conservation in New Building Design.

.4 ASME: Code for Pressure Vessels.

.5 FM.

.6 IEEE: 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

.7 IRI.

.8 NEMA:

.1 MG 1-12.53a, Motors and Generators.

.2 250.

.9 NFPA:

.1 54, National Fuel Gas Code.

.2 70, National Electrical Code.

.10 OSHA.

.11 SMACNA: Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems.

.12 UL.

.1 Gas and Oil Equipment Directory.

.13 ULC.

.14 National Fire Code of Canada.

1.2 Submittals

.1 Action Submittals: Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 When Located in a Seismic Zone 3 or Greater Region: Design and drawings for support, expansion, drainage, and guy anchor rods required to support the boiler stack in a 161 km/h wind.

.2 Informational Submittals:

.1 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

1.3 Factory Testing

.1 Witnesses: The Contract Administrator reserve the right to witness factory tests.

1.4 Structural Analysis

.1 All equipment and equipment anchoring systems shall be designed in accordance with the latest edition of the Building Code, Seismic requirements.

1.5 Quality Assurance

.1 Provide the Work in accordance with the requirement of CEC, NFPA 70 and CAN/CSA B149.1. Where required by the authority having jurisdiction, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the authority having jurisdiction.

.2 Products manufactured within scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

2. PRODUCTS

2.1 General

.1 Heating equipment shall have minimum operating efficiencies as specified in the Model National Energy Code of Canada for Buildings.

.1 Boiler Assemblies: Built in accordance with Section IV of ASME Boiler and Pressure Vessel Code.

.2 Fans: Sound power level (ref. 10 to 12 watts) at design operating point; ratings based on AMCA Bulletin 300, Setup No. 1.

2.2 Service Conditions

.1 Ambient Dry Bulb Temperature: -40 to 40 ^{o} C.

.1 Natural Gas: Inlet Pressure 1.75 to 3.5 kPa

2.3 Gas-Fired Boilers

.1 Instantaneous Gas-Fired Boilers (B-H018 & B-H019):

.1 CSA certified, direct vented, sealed combustion and forced draft with variable speed fan.

.2 Suitable for building heating water system.

.3 Natural gas fired stainless steel burner fully modulating based on water flowrate.

.4 Copper fin-tube.

.5 Pressure / temperature relief valve: ASME rated

.6 Electronic Spark Ignition system with flame sensing electrode.

.7 Modulation of Capacity shall be controlled by an on board microprocessor and thermister.

.2 Safety Features:

.1 Built-in Freeze Protection

.2 Manual Reset Hi Limit (set at 88 ^{o} C)

.3 Overheat cutoff fuse

.4 Inlet/Outlet Thermisters for constant Temperature Monitoring

.5 Flue Backdraft Pressure Switch

.6 GFI Power Supply connection

.7 Flame Sensor.

.3 Accessories:

.1 Direct Venting Kit

.2 Outdoor Vent Cap.

.3 Wall mounting kit.

.4 Performance:

.1 Input capacity = 4.4 to 58.3 kW.

.2 Efficiency = 92 to 95 percent

.5 Electrical Power:

.1 120 volt, single-phase, 0.8 amps.

.6 Acceptable Manufacturers:

.1 TAKAGI, Model T-H1

.2 Noritz

2.4 Gas Vent and Combustion Air Intake

.1 Exhaust vent shall be 100 mm diameter single wall AL 294C stainless steel type BH Special Gas Vent Certified to UL1738/ULC-S636 for use with Category III appliances.

.2 Combustion air intake shall be 75 mm diameter stainless steel pipe attached directly to the air intake collar and communicate directly with outdoors.

.3 Extended combustion air intake and exhaust vent pipes minimum 1500 mm above roof level.

.4 Terminate exhaust vent with a listed rain cap.

.5 Terminate combustion air intake pipe with a goose-neck turning downward.

2.5 Accessories

.1 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

.2 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown

2.6 Source Quality Control

.1 Inspect control panels for required construction, electrical connection, and intended function.

.2 Factory Tests and Adjustments: Test equipment actually furnished.

.1 Functional Test: Perform manufacturer's standard tests.

3. EXECUTION

3.1 Installation

.1 Boiler:

.1 Install in accordance with manufacturer's recommendations.

.2 Pipe drains and relief valve discharges to floor drain, terminating with an elbow discharging downward.

.3 Provide chain wheel operators on boiler isolation valves higher than 2 m above floor level.

.4 Flush out boiler and connecting piping prior to initial fill.

.2 Gas Vent Stack: Install in accordance with manufacturer's recommendations and requirements of NFPA 54.

3.2 Field Quality Control

.1 Functional Tests: Conduct on each boiler assisted by manufacturer's representative as follows:

.1 Startup Assistance:

.1 Inspect all gas piping, system piping with accessories, and boiler breeching.

.2 Initial startup of boiler, and observe four subsequent starts.

.3 Adjust devices in fuel piping circuit.

.4 Perform checks on operating and safety controls.

.5 Calibrate integral controls, gauges, and thermometers.

.6 Perform and furnish everything required for inspections and tests as specified herein to demonstrate that boiler and auxiliary equipment, as installed, are in compliance with Contract requirements.

.7 Adjust safety and automatic control instruments as necessary to place them in proper operation and sequence.

.8 Test instrumentation shall be calibrated and have full scale readings from 1.5 to 2 times test values.

.2 Performance Test:

.1 Conduct on each boiler assisted by Manufacturer's Representative.

.2 Perform under actual or approved simulated operating conditions.

.3 Preliminary operation test for a continuous 8-hour period without malfunction.

.4 Acceptance Operating Test and Inspection: 15 days advance notice is required.

.5 Perform tests within 90 days of commencements of operations. The Contract Administrator shall be notified 60 days in advance of the testing.

.6 Submit the final test reports within 60 days after completion of the tests.

.7 Tests shall be conducted by an authorized representative of the manufacturer of the Boiler system without any additional costs. At least 5 Business Days' notice of beginning of test shall be given to the Contract Administrator to allow witnessing of the tests. Upon completion of the tests, final adjustments and alignment check shall be made to the equipment, and the proper operation of all equipment demonstrated to the Contract Administrator and the City's representative.

3.3 Manufacturer's Services

.1 A manufacturer's representative for the equipment specified herein shall be present at the Site for the minimum person-days listed for the services hereinunder, travel time excluded:

.1 1 person-day for installation assistance, inspection, and certification of the installation, Provide Certificate of Satisfactory Installation, Form 102.

.2 1 person-day for functional and performance testing. Provide Certificate of Equipment Satisfactory Performance, Form 103.

.3 1 person-day for prestartup classroom or Site training.

.2 Training of City's personnel shall be minimum 8 hours instruction time for each boiler provided and at such locations as requested by Contract Administrator.

.3 See Section 01664 - Training, and Section 01670 - Commissioning for additional requirement details.

END OF SECTION

HEAT TRANSFER

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ANSI.

.2 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.3 ASME: Code for Unfired Pressure Vessels.

.4 ASTM: D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

1.2 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of products, and electrical schematics for all products specified.

.2 Manufacturer's standard finish color selection for enclosure finishes..

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.

.3 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

.4 Special guarantees.

1.3 Quality Assurance

.1 Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, specified in Chapter 6 of ASHRAE 90.1.

2. PRODUCTS

2.1 Double-Wall Plate and Frame Heat Exchangers (HEX-H010A, HEX-H010B)

.1 General:

.1 Individual and removable double-wall plates and gaskets contained in a carrier assembly.

.2 Designed, constructed, and tested in accordance with the ASME Code for Unfired Pressure Vessels.

.3 ASME pressure vessel labeled.

.1 Working Pressure Rating: 1516 kPag minimum at 82 ^{o}C.

.2 Relief valve sized to pressure vessel.

.3 Piping Connections: Class 150 ANSI Standard flanged nozzles.

.4 Furnish units with studded port connections integral with the unit end plate with a Class 150 ANSI Standard flanged pipe spool and gasket for each piping connection, sized to match connection and 300 mm long.

.5 Plates: Type 316 stainless steel.

.6 Gaskets: Viton, EPDM, or Nitrile.

.7 Base Anchor Bolts: 20 mm minimum diameter, Type 316 stainless steel.

.2 Performance:

.1 Total Heat Exchanged: 471 kW

.2 Cold Side:

.1 Fluid: Water

.2 Flow Rate: 16.9 L/s

.3 Entering Temperature: 23 ^{o} C

.4 Leaving Temperature: 30 ^{o} C

.5 Pressure Drop: 23 kPa

.3 Warm Side:

.1 Fluid: Water

.2 Flowrate: 16.67 L/s

.3 Entering Temperature: 33 ^{o} C

.4 Leaving Temperature: 27 ^{o} C

.5 Pressure Drop: 23 kPa

.4 Physical Dimensions:

.1 Length = 1419 mm

.2 Width = 524 mm

.3 Height = 1102 mm

.3 Acceptable Manufacturers:

.1 S.A. Armstrong; PFX-45-ST-FS-1-100

.2 Alfa Laval

2.2 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm thick (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

3. EXECUTION

3.1 Installation

.1 Heat Exchangers: Support from the concrete base with an angle iron frame and anchor securely in place.

HEAT TRANSFER

3.2 Special Guarantee

.1 Furnish Manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing, for a period of 5 years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

3.3 Manufacturer's Services

.1 Provide Manufacturer's Representative at Site in accordance with Section 01650, Equipment Installation, for installation assistance, inspection and certification of proper installation, equipment testing, startup assistance, and training of City's personnel for specified equipment.

END OF SECTION

AIR HANDLING

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ARI: 410 Forced-Circulation Air-Cooling and Air-Heating Coils.

.2 AMCA:

.1 Bulletin 300, Setup No. 1.

.2 Standard 99, Standards Handbook, Reverberant Room Method for Sound Testing of Fans.

.3 Standard 210, Laboratory Methods of Testing Fans for Rating.

.3 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 HVAC Applications chapter in “Seismic Restraint Design”.

.4 ASTM: D4157, Abrasion Resistance of Textile Fabrics (Oscillatory Cylinder Method), Test Method for.

.5 CSA: C22.1, Canadian Electrical Code

.6 IEEE: 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

.7 NEMA: MG 1-12.53a, Motors and Generators.

.8 NFPA:

.1 70, NEC.

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.3 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.9 OSHA.

.10 UL/ULC: Product Directories.

1.2 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature, which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Informational Submittals:

.1 Manufacturer's Test Reports for the following:

.1 Hydronic cooling coils.

.2 Direct Expansion (DX) coils.

.3 Heat-pipe heat recovery coils

.4 Noise test results.

.2 Equipment Installation Certificates:

.1 Certificate of Equipment Delivery, Form 100.

.2 Certificate of Readiness to Install, Form 101.

.3 Certificate of Satisfactory Installation, Form 102.

.4 Certificate of Equipment Satisfactory Performance, Form 103.

.3 Recommended procedures for protection and handling of products prior to installation.

.4 Operation and Maintenance Data: As specified in Section 01730, Operation Maintenance Manuals.

1.3 Extra Materials

.1 Furnish, tag, and box for shipment and storage the following spare parts:

Item	Quantity
Filters	Four complete sets per unit
High Efficiency Filters	Two complete sets per unit
Fan Belts	One complete set per unit

.2 Delivery: In accordance with Section 01600, Materials and Equipment.

2. PRODUCTS

2.1 General

.1 Provide non-fused disconnects on each air handling system.

.2 Coat interior surfaces and fan wheel in contact with the air stream with 6-mil minimum thickness of chemical-resistant epoxy coating.

.3 Where spark-proof construction requirements are noted, furnish equipment in accordance with AMCA Standard 99-0401 for Type B spark-proof construction.

.4 Shafts and Drive Belts:

.1 Furnish multiple drive belts where motor horsepower is 1.5 kW or larger.

.2 Belt Guards: Meet federal and Provincial of Manitoba OSHA requirements for safety protection, and be easily removable by one person.

.3 Tachometer Access Holes: Large enough to accept standard tachometer drive shaft.

.4 Center punch fan shaft to accommodate tachometer readings.

.5 Fan Equipment: Rated and tested in accordance with AMCA 210 and AMCA 2401 for Class I service, unless otherwise specified.

.6 Ball Bearings:

.1 For Forward-Curved Fans: Size for minimum life L-10 of over 80,000 hours.

.2 For Airfoil and Backward Inclined Fans: Size for minimum life L-10 of over 40,000 hours, with an average life L-50 of over 200,000 hours.

.7 Drives for Belt-Driven Fans:

.1 Sheaves shall be capable of providing 150 percent of motor horsepower.

.2 Mount motors on adjustable motor brackets.

.3 Furnish motors 75 kW and under with adjustable speed sheaves that allow for 20 percent speed variation.

.4 Furnish belt-driven fans with cast iron or flanged steel sheaves.

.8 Air Filters, Fans, Air Handlers, and Air Conditioners: Meet requirements of NFPA 90A and NFPA 90B.

.9 Acoustical Levels:

.1 Maximum allowable break-out sound pressure measured at 1.2 m away from the air handling equipment shall be limited to 80 dBA

.2 Maximum allowable discharge sound pressure measured at 2.0 m downstream of the unit discharge shall be limited to 85 dBA

2.2 Air Handling Equipment, MAU, HRU, AHU

.1 Additional Requirements

.1 Refer to Equipment schedules supplement to this section, Schematic drawings and specification Section 15900, HVAC Instrumentation and Controls – General for additional requirement for each Air Handling System.

.2 All electrical control panels shall be approved by an Accredited Certification Organization as defined in the Canadian Electrical Code.

.2 Unit Construction:

.1 Unit casing shall be of minimum 16 gauge satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish shall be a two-part epoxy with polyurethane topcoat, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 Unit shall be provided with 22 gauge solid galvanized metal liner over all insulated areas of sidewalls and roof. Finish side of the liner that is in contact with the airstream shall be a two-part epoxy applied in the same fashion as that on the unit casing.

.3 All units shall be internally insulated with 48 kg per cubic metre density acoustic insulation. Insulation thickness shall match wall thickness of 50mm. Insulation shall be secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.4 All walls, roofs and floors shall be of formed construction; with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water-resistant sealant..

.5 Units shall be provided with access doors to all components within the unit. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.1 Provide hinged access doors, fully lined, with stainless steel piano hinges and brass pins, in welded steel frames. Doors shall be fully lined with automotive bulb

gasket and nylon 6/PA6 lever type handles, operable from both sides for all units over 1.2 m high. Units 1.5 m and above in height to have three handles per door.

.2 Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label must be affixed.

.3 Hinged access doors shall be provided with tie back clips.

.4 Door directly upstream of cooling coil and all doors downstream of cooling coil shall have thermal breaks to minimize sweating.

.6 Casings shall be supported on structural channel supports, designed and welded for low deflections. Integral lifting lugs shall be provided for hoisting.

.7 Drain pans, where required, shall be an integral part of the floor paneling, a minimum of 50 mm deep, with welded corners. Drain pans shall extend a minimum of 150 mm downstream of coil face and be provided with a 40 mm M.P.T. drain connection. Drain pans must be sloped and pitched such that there is no standing water. Intermediate drain pans shall be provided between cooling coils above 1.6 m. Drain pans shall be Type 316 stainless steel.

.3 Fans:

.1 Fans shall be backward inclined or airfoil design and rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20 percent below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating. Fans shall be equipped with greaseable, self-aligning ball or roller type pillow block bearings, supported on a rigid structural steel frame. Fan scroll and wheel shall be aluminum. All other parts of the assembly (except for shaft, bearings, and isolators) shall be epoxy or heresite coated.

.2 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.3 Provide epoxy coated belt guards on all units.

.4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be vertical spring type with leveling bolts, bridge bearing waffled pads with minimum 1 inch static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.5 Fan motors shall be totally enclosed TEFC high efficiency type.

.4 Filters:

.1 Filter sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as shown on the drawings.

.2 Filter media shall meet U.L. Class 2 standards.

.3 Each filter bank shall be provided with a flush-mounted Magnahelic air filter gauge with adjustable signal flag (Dwyer Series 2000, or approved equal).

.4 Winter-Filters, Summer Filters, Pre-Filters: 50 mm pleated panel disposable filters, non-woven reinforced cotton/poly fabric media with a metal support grid and heavy duty beverage board-enclosing frame. Permanent re-usable metal enclosing frame. The filter media shall have an average efficiency of 30 to 35 percent + on ASHRAE Standard 52.1.

.5 Final Filters: Rigid self-supporting extended surface disposable filters consisting of high density synthetic media, media support grid, metal contour stabilizers, metal diagonal support bracing and enclosing frame. Media shall be 3 ply, dual stage synthetic. Pre-filter layer of coarse 7 to 10 micron synthetic fibers; secondary ply of progressively structured spun bonded polypropylene fibers blended with filaments from 1 to 6.7 microns; and final ply of spun bonded polypropylene backing with strength to support filtering stages. The media shall withstand 100 percent humidity and be non-shedding. Media shall have an average atmospheric efficiency of 95 percent, with an average arrestance of 96 to 100 percent when tested to ASHRAE 52.1 - 1992. Media shall be quality certified by ISO-9002.

.5 Motorized Dampers:

.1 Motorized dampers shall be provided as indicated on schematic drawings and here-in described. Motorized dampers shall e of High Performance type as specified under Section 15901, HVAC Control, Field components, and Instruments.

.2 Motorized dampers and actuators shall be factory mounted and pre-wired with proper interlocks to fan.

.6 Coils, where applicable:

.1 Coils shall be constructed of copper tube and aluminum fin with copper headers. Fins constructed of aluminum or copper shall be rippled for maximum heat transfer and shall be mechanically bonded to the tubes by mechanical expansion of the tubes. The coils shall have a Type 316 stainless steel casing. All coils shall be factory tested with air at 2068 kPa while immersed in an illuminated water tank.

.2 Coils shall be ARI 410 performance rated.

.3 Headers shall be located inside of the air handler unit and arranged for counterflow between air and water. Locate supply and return connections on same side.

.4 Coils shall be removable from the unit at the header end, unless shown otherwise on the drawings. All water coils shall be equipped with a capped vent tapping at the top of the return header, and a capped drain tapping at the bottom of the supply header. Coils shall be completely drainable.

.5 Water coils shall be circuited to provide adequate tube velocities to meet design requirements. Internal turbulators are not acceptable.

.6 Refrigerant Superfin evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Hot gas bypass inlet shall be at the refrigerant distributor.

.7 Refrigerant coils shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions.

.8 Provide Heresite P-413, a pure phenolic thermosetting resinous coating, to protect coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing.

.7 Indirect Gas Fired Burner (Up to 410 kW), where applicable:

.1 General

.1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.

.2 All units must exceed the ASHRAE 90.1 requirement of steady state efficiency at low fire.

.3 Operating natural gas pressure at unit(s) manifold shall be 1.75 to 3.50 kPa.

.4 Gas manifolds shall be provided to FM standards.

.5 Gas fired units shall be approved for operation in -40°C locations.

.2 Heat Exchanger

.1 Heat exchanger shall be a primary drum and multi-tube secondary assembly constructed of titanium stainless steel with multi-plane tubulators, and shall be of a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 25 mm of insulation

between the outer cabinet and inner liner. Blower assemblies close coupled to duct furnace type heat exchangers are not acceptable.

.2 Heat exchangers shall be tested and certified to ANSI standards to provide a minimum of 80% efficiency throughout the entire operating range as required by ASHRAE 90.1. The manufacturer shall be routinely engaged in the manufacture of this type of high efficiency equipment.

.3 Burner

.1 The burner assembly shall be a blow through positive pressure type with an intermittent pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay complete with flame rod. The burner and gas train shall be located inside a cabinet enclosure. Insulation in the burner section shall be covered by a heat reflective galvanized steel liner. Atmospheric burners, or burners requiring power assisted venting are not acceptable.

.2 Provide discharge air temperature control with 15:1 turndown capability for all input capacities in range from 29.3 kW to 410 kW. The high turndown burner minimum input shall be capable of controlling at 6.7% of its rated input without on-off cycling and include built in electronic linearization of fuel and combustion air. Efficiency shall increase from Hi to Lo fire.

.4 Venting

.1 Installation and venting provisions must be in accordance with CGA Standard B149.1, ANSI Z223.1-NFPA54, and local authorities have jurisdiction. Type A, L, and/or PS venting is required.

.5 Burner Controls

.1 The gas fired heating controller shall be Electronic Modulating Fuel with Modulating Combustion Air. This shall incorporate a solid state analyzer complete with proportional and integral control and with a discharge air sensor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature. Combustion air motor speed varies in response to the modulation of gas flow to provide optimum fuel/air mixture and efficiency at all conditions.

.2 Combustion efficiency of high efficiency heat exchangers shall increase 4 – 5% from high fire to low fire. Heat exchangers shall provide a minimum of 80% efficiency throughout the entire operating range.

.3 As an alternative to variable speed combustion air blower, the burner control shall include a modulating gas valve and a combustion air damper with a linear linkage connected to an actuator which has a minimum of 100 steps of control.

.4 Burner controls shall include the following standard features:

.1 Linear gas and combustion air flow obtained via a built in solid state linear algorithm

.2 Minimum operating ambient temperature: -40°C

.3 Four (4) air change pre-purge on units with over 117 kW input

.4 Post purge

.5 Interrupted pilot

.6 Self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances

.7 Low fire start

.8 Controlled burner start-up and shut down

.9 Diagnostic lights for ease of set-up and service

.10 Blower contactor that starts fan after burner pre-purge

.11 Damper contact that allows fan to start after damper opens, damper to close after fan stops and damper to close on flame failure

.12 Non-recycling auto by-pass low limit that has built-in sensor checking

.5 Burner controller shall modulate heating output to maintain supply air temperature set-point. Refer to Factory-mounted Pre-wired Control section for interfacing details with BAS.

.8 Indirect Fired Heat Exchanger (Above 410 kW), where applicable.

.1 General

.1 Heating units shall be indirect natural gas fired approved for both sea level and high altitude areas. The entire package, including damper controls, fan controls, and all other miscellaneous controls and accessories shall be approved by an independent testing authority, and carry the approval label of that authority as a complete operating package.

.2 Operating natural gas pressure at unit(s) manifold shall be 1.75 to 3.50 kPa.

.3 Gas manifolds shall be provided to FM standards.

.4 Gas fired units shall be approved for operation in -40°C.

.2 Heat Exchanger

.1 Heat exchanger shall be a primary cylindrical drum, of welded titanium stainless steel with multi-tubed stainless steel secondary, complete with multi-plane metal turbulators. Heat exchanger must utilize a floating suspension system to allow free thermal expansion and contraction without stress. Heat exchanger shall be provided with condensate drain connection. The heat exchanger casing shall have 25 mm of insulation between the outer cabinet and inner liner. Diamond shaped heat exchangers are not acceptable. Dual or triple blower assemblies, as required to ensure even air distribution across heat exchangers, shall be provided. Blowers assemblies close coupled to duct furnace type heat exchangers are not acceptable.

.3 Burner

.1 Burner shall be a blow through positive pressure type with built in electronic linearization of the combustion air damper and gas valve curves producing higher efficiencies at reduced loads and, a certified efficiency of 80% or greater throughout its operating range. Flame surveillance shall be with a solid state programmable relay utilizing a flame rod ultra violet sensor. Insulation in the burner section shall be covered with a heat reflective galvanized steel liner secured with rivets. Atmospheric burners or burners requiring power assisted venting are not acceptable.

.4 Venting

.1 Installation and venting provisions must be in accordance with C.G.A. Standard B149.1, ANSI Z223.1-NFPA54, and Local Authority having Jurisdiction. Type A, L and/or PS venting is required.

.5 Burner Controls

.1 Unit shall be provided with an Electronic Modulating Fuel with Modulating Combustion Air controller with a solid state analyzer complete with proportional and integral control and with a discharge air thermistor to maintain set point temperature and provide rapid response to incremental changes in discharge air temperature.

.2 The burner controls shall include the following standard features:

.1 Minimum operating ambient temperature: -40°C

.2 Built-in pre-purge

.3 Built-in post purge

.4 self check on start-up to make sure air proving and discharge air sensors are operating within design tolerances

.5 Low fire start

.6 Inlet damper control

.7 Diagnostic lights for ease of set-up and service

.8 Non-recycling auto bypass low limit with alarm contacts

.9 Blower contactor that starts fan after burner pre-purge

.10 Controlled burner start-up and shut down

.11 Built in electronic linearization of the combustion air damper and gas valve producing higher efficiencies and reduced inputs

.3 Burner controller shall modulate heating output to maintain supply air temperature set-point. Refer to Factory-mounted Pre-wired Control section for interfacing details with BAS.

.9 Economizer Mixing Section, where applicable:

.1 Include mixing dampers on return and outside air inlets.

.2 Position opposed-blade dampers across the long dimension of each air opening, with linkage arranged so corresponding outside and return air dampers move together.

.3 Furnish either the combination style box, or a two-piece assembly with a vee filter box and high efficiency mixing box bolted together.

.4 Install damper linkage at the factory to provide minimum and maximum damper segments proportional to quantities of minimum and maximum outside air requirements.

.10 Heat Recovery Section, where applicable:

.1 Provide an air-to-air heat pipe exchanger with performance as shown in the schedule. Refrigerant utilized in heat pipes shall be R-407C. Non-HFC refrigerant will not be accepted.

.2 Heat exchanger core shall be of 25 mm, seamless aluminum tubing permanently expanded into fins. Each tube shall be an individually sealed heat pipe filled with a working fluid conforming to Group 1 in the American National Standard Safety Code for Mechanical Refrigeration. Tubes shall include flow separators whenever vapour and condensate streams interact limiting the heat transfer capacity of the pipe.

.3 The secondary surface shall be continuous plate aluminum fins design to produce maximum heat transfer efficiency. Spiral fins are not acceptable

.4 The capillary wick of each heat pipe shall be an integral part of the inner wall of the tube to provide a completely wetted surface for maximum heat pipe capacity, with minimum heat transfer resistance. Heat pipes manufactured without capillary wick or where the wick is not acceptable to the Contract Administrator shall have a minimum of 20% additional rows than that shown in the schedule. Where additional rows are provided, the heat pipe shall be increased in face area to provide a pressure drop equal or less than that shown in the schedule.

.5 Provide Heresite P-413, a pure phenolic thermosetting resinous coating, to protect coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing

.6 The supply air side shall be equipped with opposed blade face and bypass dampers with accompanying linkage and operating controls

.7 Provide a dedicated solid state controller complete with a control actuator that will effectively modulate the face and bypass damper to achieve the following:

.1 Accurate supply air temperature control

.2 Summer/Winter operation changeover

.3 Frost prevention on the exhaust air side

.8 In conditions when the exhaust air could provide more heat than is required, the bypass damper is varied by the controller to limit heat transfer and maintain supply air set point. When outside air is cold enough to extract heat from the exhaust air to the point where frost will form on the exhaust side of the heat pipe, the controller will increase the bypass to limit heat transfer and keep the exhaust air above the frost threshold

.9 Frost control bypass shall be sized so that total air flow is unchanged in bypass mode. Bypass dampers shall be low leakage. By-pass damper and actuator shall be High Performance type as specified under Section 15901 - HVAC Controls, Field components and Instruments.

.11 Water Cooled DX Cooling Section, where applicable

.1 Water-cooled DX-Cooling section shall be provided as an integral part of the air handling unit. Skid mounted condensers or compressors are not acceptable.

.2 This system shall utilize R-407C refrigerant. Non-HFC refrigerant will not be accepted.

.3 Compressors shall be hermetic reciprocating or scroll type, 3,600 rpm, set on resilient neoprene mounts and complete with line voltage break internal overload protection,

internal pressure relief valve. All compressors controls shall be equipped with anti-short cycle and inter-stage protection and shall be protected with crankcase heaters.

.4 Water-cooled condenser heat exchanger shall be coaxial, tube-in design, helically wound with convoluted copper inner tube for water, with a steel outer tube to carry refrigerant in the annular space. Working pressures: 2068 kPag, water-side and 3100 kPag, refrigerant side. Condensers shall be C.S.A. and U.L. approved and labeled. Provide a condenser for each compressor. All refrigeration piping and water connections internal to the unit shall be by the unit manufacturer. The Manufacturer shall provide one condenser water inlet and one condenser water outlet connection external to the unit for hookup.

.5 Provide Heresite P-413, a pure phenolic thermosetting resinous coating, to protect the coils against exposure to corrosive atmospheres. The process shall be accomplished by a multiple coat application of degreasing and etching, dipping and baking (four times), resulting in complete coating coverage of the fins, tubes, headers and casing.

.6 Controls for hermetic compressor units shall include compressor, 3-way head pressure control valves, refrigeration diverting valves for temperature control, receivers, control circuit transformer, cooling relays, manual reset high pressure controls and automatic reset low pressure controls. The manufacturer is to be responsible for all control valves, refrigeration and water side isolation valves, and all refrigeration and water diverting valves mounted interior to the unit.

.7 All refrigerant specialties to be provided and factory installed and tested by the manufacturer.

.8 Where a free-cooling coil is required, it shall be provided as and integral part of this section. The control of water circulating through the coil is part of the internal unit control.

.9 The Free-cooling coil shall be internally piped in series with the condenser heat exchanger of the DX-Cooling system,

.10 When cooling is required, Free-cooling shall be the first priority to consider before DX-Cooling. The internal unit control shall monitor the temperature of the water leaving the Free-cooling coil and by-pass the coil when this temperature is higher than the design entering condenser water temperature for the DX-Cooling system.

.11 The internal piping and control system shall include compensating balancing valves such that the condenser water flow rate and pressure drop at the unit connections shall be constant and stable.

.12 Gas Fired Steam Humidifier, where applicable

.1 Humidifier unit shall have a natural gas fired steam generating system that is approved for both sea level and high altitude areas. The entire assembly shall be approved and

labeled by a nationally recognized certification organization. Gas manifolds shall be provided to FM standards

.2 Operating natural gas pressure at unit(s) manifold shall be 1.75 kPa to 3.5 kPa

.3 Heat Exchanger shall be primary drum and multi-tube secondary assembly constructed of 316L, stainless steel with multi-plane metal turbulators, and shall be a floating stress relieved design. Heat exchanger shall be provided with condensate drain connection.

.4 The burner assembly shall be a blow through positive pressure type with an interrupted pilot ignition system to provide a high seasonal efficiency. Flame surveillance shall be with a solid state programmed flame relay complete with flame rod. The burner and gas train shall be located inside a NEMA 4 cabinet enclosure.

.5 Modulation capability shall be 15:1 turndown for all input capacities. The high turndown burner's minimum input shall be 6.7% of its rated input without on-off cycling.

.6 Installation and venting provisions must be in accordance with C.G.A. Standard B149.1, or ANSI Z223.1-NFPA54, and local authorities having jurisdiction. Type A, L and/or PS venting is required.

.7 Evaporating tank shall be constructed of 316L stainless steel with welded seams, complete with removable access cover(s) to facilitate service and inspection. The tank shall be mounted in a heavy gauge, stain coat steel casing, insulated with 25mm, 24 kgs per cubic metre density insulation to insure minimum heat loss from the evaporating tank.

.8 Steam distribution system shall incorporate the stainless steel distribution manifold with metered orifices. Orifices shall draw steam from the centre of the distribution tube to utilize the driest steam available

.9 Units shall be controlled by a solid state analyzer incorporating proportional and integral control complete with sensor to maintain space relative humidity requirements and respond to incremental changes in relative humidity. The combustion air fan shall have a variable speed controller, which tracks the modulation of the gas flow to provide optimum fuel/air mixture and efficiency at all required firing conditions.

.10 Combustion efficiency of the heat exchanger shall increase from Hi fire to Lo fire while achieving a 15:1 turndown. Heat exchangers shall provide a minimum of 80% efficiency throughout the entire operating range

.11 Provide water level control, freeze protection, auto fill, and delay flush cycle

.12 Combustion controllers for humidification units shall include the following standard features:

.1 Linear gas and combustion air flow obtained via a built in solid state controller

.2 Four (4) air change pre-purge

.3 Interrupted pilot and post purge

.4 Self check on start-up to ensure combustion air proving switch is operational

.5 Lo fire start with controlled burner start-up and shut down

.6 diagnostic lights for ease of set-up and service indicating:

.1 Purge Mode

.2 Pre Purge Malfunction

.3 Combustion Enabled

.13 Factory-Mounted Pre-Wired Controls:

.1 Provide a single-point power connection for entire unit.

.2 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.3 Unit shall bear a label by a nationally recognized certification organization with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.

.4 Provide a system of motor control, including all necessary terminal blocks, motor starters, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Provide a main non-fused NEMA 4 disconnect switch for each Air Handler System.

.5 Provide a 1.5 kVA transformer for the purpose of supplying 115V-1ph power to a field-mounted networked DDC controller. Refer to Section 15900 for additional details on the interfaces with the networked DDC controller.

.6 Provide a NEMA 4 control cabinet mounted on the outside of the unit casing, which shall be adequately sized to include an allocated 600mm x 600mm space for mounting the Networked DDC controller.

.7 All input and output interfacing points with the Networked DDC controller shall be factory terminalised with proper identification on a control strip mounted adjacent to the space allocated for the Networked DDC controls

.8 Where water-cooled DX-cooling section is required, the Factory-mounted electronic temperature control system shall have the capability of providing multiple stages of cooling control to maintain supply air temperature. The minimum run and off time for compressors shall be 4 minutes at full load startup, and may range up to 8 minutes

under part load conditions. The controller shall incorporate a proportional, integral control algorithm that reduces temperature drop by resetting to the set-point after each stage is cycled on.

.9 Where an Economizer Mixing section is required, upon an Economizer Mode enable signal from the BAS, the Factory-mounted controller shall modulate the mixing dampers to maintain supply air temperature set-point. Additional mechanical cooling shall be enable should the mixing damper is not able to satisfy the supply air temperature set-point.

.10 Where a Gas Burner section is required, the Factory-mounted controller shall modulate the burner output capacity, utilizing proportional and integral control algorithm to maintain supply air temperature set-point with 4-20mA or 0-10v reset provided by the Building Automation System (BAS).

.11 Factory-mounted controller shall be capable of interfacing with the BAS all the input/output points and alarms as shown on system schematic drawings and as described in Section 15900, HVAC Instrumentation and Controls – General

.12 In addition to internal control devices required for the operation of the factory mounted internal control system, provide all control devices shown within the outline of the Air Handling Equipment as indicated on the Schematic drawings.

.13 Refer to specification Section 15901 HVAC Control, Field Components and Instruments for specific requirements of control devices.

.14 Ensure that all interfacing control signals from devices and sensors are compatible with the BAS system.

.15 Provide factory-mounted Hand-Off-Computer (HOC) switch for single speed system and Slow-Off-Fast-Computer (SOFC) switch for two-speed systems.

.14 Manufacturers:

.1 Engineered Air.

.2 Haakon Industries.

.3 Trane.

.4 Carrier.

2.3 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 9.5 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.4 Source Quality Control

.1 Manufacturer's Tests:

.1 Direct expansion cooling coil leak tested underwater with 2068 kPa air.

.2 Indirect Fired Heating as follows:

.1 Tests shall be performed after complete final unit assembly, just prior to shipping to Site. The tests shall be performed in accordance with the equipment standard that the gas heating section is certified.

.2 Heat exchanger shall be tested by measuring the gas burning rate with a dedicated calibrated gas meter to insure proper set up of the gas manifold.

.3 High and Low input flue gas combustion analysis using a calibrated combustion analyzer including O_2 and CO to provide proper air fuel ratio.

.4 Two (2) equally spaced intermediate firing rates between high and low shall be analyzed to insure proper air-fuel ratio throughout the firing range.

.5 A copy of the combustion test report shall be provided.

.6 Water Coils: No leaks when tested underwater with 1378 kPa air.

3. EXECUTION

3.1 Installation

.1 Air Handlers:

.1 Pipe drain pan connection through a running trap to floor drain.

.2 Isolate sheet metal duct connections from all noninternally spring-isolated fan units or other rotating equipment.

.3 Locate units to provide access spaces required for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

.4 Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.2 Adjusting and Cleaning

.1 Air and Water System Balancing: As specified in Section 15950, HVAC Systems Testing, Adjusting, and Balancing.

.2 Air Handlers:

.1 Lubricate nonsealed bearings prior to startup.

.2 Do not operate units until filters are installed. If operated without filters, completely clean coils and interior of units.

.3 Vibration:

.1 Statically and dynamically balance all rotating equipment.

.2 Perform field testing on rotating equipment to ensure there is no excessive vibration.

.3 If excessive vibration is experienced, rebalance equipment in-place to the satisfaction of the Contract Administrator.

3.3 Manufacturer's Services

.1 Provide Manufacturer's services in conformance with the requirements of Section 01650, Equipment Installation. Manufacturers Representative shall provide support of equipment installations and field inspection of equipment before startup.

.2 Duration of Training: The training of City's personnel shall be carried out as per Section 01664, Training.

3.4 Special Guarantee

.1 Furnish Manufacturer's extended guarantee or warranty, with the City named as beneficiary, in writing for a period of 2 years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

3.5 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.1 15720-01 Heat Recovery Unit (HRU) Schedule

.2 15720-02 Gas-Fired Make-up Air Unit (MAU) Schedule

.3 15720-03 Air Handling Unit (AHU) Schedule

END OF SECTION

HEAT RECOVERY UNIT (HRU) SCHEDULE
15720-01

Equipment Tags	AREA SERVED	SUPPLY FAN DATA							HEAT RECOVERY HEATING PIPE				SUPPY SIDE FILTER DATA			
		PERFORMANCE			MOTOR DATA				SUPPLY SIDE				SUMMER FILTER		WINTER FILTER	
		L/s	ESP.	RPM	[kW]	RPM	VOLT	PH	EAT	LRH	LAT	PD	EFFIC.	PD	EFFIC.	PD
			[Pa]						[C]	[%]	[C]	[Pa]	%	[Pa]	%	[Pa]
HRU-H022	Ozone Generator Room Heating and Ventilation	4,245	250	1964	11.2	1800	575	3	-40	100	-30	63	30	150	30	150
HRU-H034	Maintenance Workshop Heating and Ventilation	2,877	313	1642	5.6	1800	575	3	-40	100	-30	70	30	150	30	150

Equipment Tags	AREA SERVED	EXHAUST FAN DATA							HEAT RECOVERY HEATING PIPE				EXHAUST SIDE FILTER DATA			
		PERFORMANCE			MOTOR DATA				EXHAUST SIDE				SUMMER FILTER		WINTER FILTER	
		L/s	ESP.	RPM	[kW]	RPM	VOLT	PH	EAT	LRH	LAT	PD	EFFIC.	PD	EFFIC.	PD
			[Pa]						[C]	[%]	[C]	[Pa]	%	[Pa]	%	[Pa]
HRU-H022	Ozone Generator Room Heating and Ventilation	4,245	188	2175	5.6	1800	575	3	16	50	5	80	30	150	---	---
HRU-H034	Maintenance Workshop Heating and Ventilation	2,877	313	1459	3.7	1800	575	3	16	50	5	90	30	150	---	---

Equipment Tags	AREA SERVED	GAS FIRED BURNER				PHYSICAL DATA				ELECTRICAL DATA					REMARKS
		EAT	LAT	CAPACITY		WEIGHT	DIMENSIONS			MOTOR				M.F.A.	
				INPUT	OUTPUT		L	W	H	[kW]	RPM	VOLT	PH	[Amps]	
		[C]	[C]	[kW]	[kW]	[kg]	[mm]	[mm]	[mm]						
HRU-H022	Ozone Generator Room Heating and Ventilation	-40	20	381	305	6818	6248	3785	2134	11.2/5.6	1800	575	3	19	
HRU-H034	Maintenance Workshop Heating and Ventilation	-40	23	278	220	6818	5664	3683	1829	5.6/3.7	1800	575	3	32	(1)

LEGEND:

EAT ENTERING AIR TEMPERATURE
LAT LEAVING AIR TEMPERATURE
PD PRESSURE DROP
DB DRY BULB
WB WET BULB
ESP EXTERNAL STATIC PRESSURE
LRH LEAVING RELATIVE HUMIDITY
M.F.A. MAIN FEEDER AMPACITY

REMARKS:

1 Provide two speed two windings with 50% speed reduction for both supply and exhaust fans.

GAS FIRED MAKE-UP AIR UNIT (MAU) SCHEDULE
15720-02

EQUIPMENT TAGS	AREA SERVED	FAN DATA			ELECTRICAL DATA					NATURAL GAS FIRED BURNER			
		CAPACITY		SPEED	MOTOR				M.F.A.	EAT	LAT	INPUT	OUTPUT
		L/s	ESP.	RPM	[kW]	RPM	VOLT	PH	[Amps]	[C]	[C]	kW	kW
MAU-H001	Filter Gallery Supply	5,660	250	1700	11.2	1800	575	3	15	-40	22	528	422
MAU-H011	Pilot Plant Room Supply	2,547	250	2280	5.6	1800	575	3	5	-40	21	234	188
MAU-H012	Residual Room Supply	6,840	250	2650	2 x 5.6	1800	575	3	15	-40	23	645	516
MAU-H021	Ozone Generation Room Emergency Supply	6,415	188	1650	11.2	1800	575	3	15	-40	2	410	324
MAU-H031	Polymer Storage Room Supply	2,547	250	2071	3.7	1800	575	3	5	-40	23	220	178
MAU-H032	Peroxide Storge Room Supply	943	188	2000	1.5	1800/900	575	3	5	-40	22	88	70
MAU-H033	SBS Storage Room Supply	1,226	188	2190	2.2	1800/900	575	3	33	-40	22	117	95
MAU-H051	DAF Process Gallery Supply	12,877	375	1525	2 x 11.2	1800	575	3	50	-40	18	1114	891

EQUIPMENT TAGS	AREA SERVED	AIR FILTRATION DATA						PHYSICAL DIMENSIONS				REMARKS
		SUMMER FILTER		WINTER FILTER		FINAL FILTER		WEIGHT	DIMENSIONS mm			
		EFFIC.	PD	EFFIC.	PD	EFFIC.	PD					
		%	[Pa]	%	Pa	%	[Pa]	[kg]	L	W	H	
MAU-H001	Filter Gallery Supply	30	150	30	150	95	350	3400	6858	2413	1829	
MAU-H011	Pilot Plant Room Supply	30	150	30	150	95	350	2682	4623	2057	1321	
MAU-H012	Residual Room Supply	30	150	30	150	---	---	3550	5893	2591	1651	
MAU-H021	Ozone Generation Room Emergency Supply	30	150	30	150	---	---	2900	5207	2134	1702	
MAU-H031	Polymer Storage Room Supply	30	150	30	150	---	---	2150	3607	2057	1321	
MAU-H032	Peroxide Storge Room Supply	30	150	30	150	---	---	1375	3200	1397	1143	1
MAU-H033	SBS Storage Room Supply	30	150	30	150	---	---	1364	3200	1397	1143	1
MAU-H051	DAF Process Gallery Supply	30	150	30	150	---	---	5100	6883	3912	1930	

LEGEND:

EAT ENTERING AIR TEMPERATURE
LAT LEAVING AIR TEMPERATURE
PD PRESSURE DROP
ESP EXTERNAL STATIC PRESSURE
M.F.A. MAIN FEEDER AMPACITY

REMARKS:

1 - 2-speeds with 50% Reduction

AIR HANDLING UNIT (AHU) SCHEDULE
15720-03

EQUIPMENT TAGS	AREA SERVED	FAN DATA			MOTOR DATA				GAS FIRED BURNER				GAS FIRED HUMIDIFIER		ELECTRICAL DATA			
		CAPACITY		SPEED									GAS	STEAM				
		[L/s]	E.S.P.	RPM					EAT	LAT	INPUT	OUTPUT	INPUT	OUTPUT	VOLT	PH	Hz	M.F.A
			[Pa]		kW	RPM	VOLT	PH	[C]	[C]	[kW]	[kW]	kW	kg/hr				[Amps]
AHU-H035	Electrical Room No. 2	1,132	188	2350	2.24	1800	575	3	---	---	---	---	---	---	575	3	60	16
AHU-H061	RW Pump Room	6,792	188	1457	11.19	1800	575	3	---	---	---	---	---	---	575	3	60	63
AHU-H062	Electrical Room No. 1	1,509	188	2600	3.73	1800	575	3	---	---	---	---	---	---	575	3	60	18
AHU-H071	Admin Area Ventilation System	1,521	250	3119	3.73	1800	575	3	-40.0	18.3	131.9	106.7	35.2	40.9	575	3	60	28

EQUIPMENT TAGS	AREA SERVED	AIR FILTRATION DATA				WATER SOURCE COOLING SECTION												
		PREFILTER		FINAL FILTER		CONDENSER WATER		FREE COOLING COIL										
		EFFIC.	PD	EFFIC.	PD			COIL CHARACTERISTICS				AIR SIDE					WATER SIDE	
		%	Pa	%	[Pa]	FLOW	PD	CAPACITY [kW]		ROWS	FINS	EAT [C]		LAT [C]		PD	EWT	LWT
						[L/s]	[kPa]	Total	Sens.		FPI	DB	WB	DB	WB	[Pa]	[C]	[C]
AHU-H035	Electrical Room No. 2	30	150	95	350	0.95	91.5	---	---	---	---	---	---	---	---	---	---	---
AHU-H061	RW Pump Room	30	150	---	---	5.43	127.5	132.2	100.8	3	10	29.0	20.8	16.7	15.6	110.2	10.0	15.3
AHU-H062	Electrical Room No. 1	30	150	95	350	1.20	74.8	---	---	---	---	---	---	---	---	---	---	---
AHU-H071	Admin Area Ventilation System	30	150	95	350	1.89	76.2	---	---	---	---	---	---	---	---	---	---	---

EQUIPMENT TAGS	AREA SERVED	WATER SOURCE COOLING SECTION (Continues)											PHYSICAL DATA				REMARKS
		WATER COOLED MECHANICAL COOLING															
		WATER SIDE		DX COIL								COMP.	WEIGHT	DIMENSIONS [mm]			
		EWT	LWT	Capacity [kW]		ROWS	FINS	EAT [C]		LAT [C]		QTY.	[kg]	L	W	H	
		[C]	[C]	Total	Sens.		FPI	DB	WB	DB	WB						
AHU-H035	Electrical Room No. 2	27	32	19.3	14.9	4	8	29.0	20.8	18.1	16.4	2	1273	2261	1575	1143	
AHU-H061	RW Pump Room	27	33	132.3	101.1	4	10	29.0	20.8	16.7	15.6	4	3091	3429	2489	1473	
AHU-H062	Electrical Room No. 1	27	32	83.4	64.8	3	10	29.0	20.8	18.6	16.6	2	1455	2261	1575	1143	
AHU-H071	Admin Area Ventilation System	27	32	38.6	21.1	6	10	30.0	23.0	15.2	14.7	3	2955	6274	1829	1422	

LEGEND:

EAT ENTERING AIR TEMPERATURE
LAT LEAVING AIR TEMPERATURE
PD PRESSURE DROP
QTY. QUANTITY
EWT ENTERING WATER TEMPERATURE
LWT LEAVING WATER TEMPERATURE
FPI FINS PER INCH
COMP. REFRIGERANT COMPRESSORS
DB DRY BULB
WB WET BULB
ESP EXTERNAL STATIC PRESSURE
M.F.A. MAIN FEEDER AMPACITY

REMARKS:

UNITARY AIR-CONDITIONING EQUIPMENT

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ARI: 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

.2 AMCA: Bulletin 300, Setup No. 1.

.3 ASHRAE:

.1 52, Method of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

.2 90.1, Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings.

.3 HVAC Applications chapter in Seismic Restraint Design.

.4 ASTM:

.1 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

.2 D2370, Standard Test Method for Tensile Properties of Organic Coatings.

.3 D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.

.4 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.5 G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

.6 A123 / A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.5 CSA.

.6 cETL.

.7 ISO: ISO 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.

.8 NEMA.

.9 NFPA: 255, Method of Test of Surface Burning Characteristics of Building Materials

.10 UL: UL 94-5V, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.2 Definitions

.1 The following is a list of abbreviations which may be used in this Section:

.1	COP:	Coefficient of Performance.
.2	EER:	Energy Efficiency Ratio.
.3	DX:	Direct Expansion.
.4	WSHP:	Water Source Heat Pump.
.5	IR:	Infrared.
.6	LED:	Light Emitting Diode.
.7	PSC:	Permanent Split Capacitor.
.8	PTAC:	Packaged Terminal Air Conditioner.
.9	SPST:	Single Pole, Single Throw.
.10	TXV:	Thermostatic Expansion Valve.

1.3 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.

.2 Manufacturer's standard finish color selection for enclosure finishes.

.3 Complete performance data that will indicate full compliance with the specifications; include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.

.2 Informational Submittals:

.1 Manufacturer's Installation Certificates, Certificate of Satisfactory Installation in accordance with Section 01650, Equipment Installation, for heat pumps, air conditioning units, and motors.

.2 Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.

.3 Sample copy of guarantee.

.4 Test reports.

.5 Operation and Maintenance Data in conformance with Section 01730, Operation and Maintenance Manuals.

.1 Include wiring and control diagrams for equipment.

.2 Include as-built version of equipment schedules.

1.4 Quality Assurance

.1 Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in ASHRAE 90.1.

.2 Unit shall be rated (when matched with appropriate outdoor unit) per ARI 210/240.

.3 Units shall be certified by UL and CSA, and shall be UL or cETL listed and labeled.

.4 Cooling performance rated in accordance with ARI testing procedures.

1.5 Delivery, Storage and Handling

.1 Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

.2 Protection of Equipment:

.1 Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.

.2 Protect from exposure to corrosive fumes and keep thoroughly dry at all times.

.3 Store motors, drives, electrical equipment, and other equipment with anti-friction or sleeve bearings in weathertight and heated storage facilities prior to installation.

.4 For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.6 Extra Materials

.1 Tools: Furnish one complete set of special tools recommended by the Manufacturer for maintenance, dismantling, or repair of each separate type of equipment. Furnish a tool box for storage of the special tools. Identify with the associated equipment number by means of a stainless steel or solid plastic nametag attached to the box.

2. PRODUCTS

2.1 General

.1 Specified components of this Section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

.2 Multiple Compressor Units:

.1 Provide completely independent refrigeration circuits and controls.

.2 Indoor unit air coils shall have intermingled circuits, unless specified otherwise.

2.2 Equipment Schedules

.1 Refer to Supplements.

2.3 Packaged Indoor Water-Source Heat Pump Units

.1 This Specification section applies to all WSHP units serving the air-conditioned spaces within the Administration Area and the Maintenance Area.

.2 General:

.1 Factory assembled, packaged indoor water-source heat pump unit shall be reverse cycle heating/cooling units using condenser water

.2 Heat pump units shall be EXTRA QUIET mode (Mute package). Heat pump radiated noise below ceiling MUST NOT EXCEED 35 dB (re 20 micro Pa).

.3 Heat pump units shall be listed by nationally recognized safety testing laboratory, or agency, such as cETL or CSA.

.4 Hang each horizontal unit from building structure with suitable anti-vibration mountings.

.5 Set each vertical unit on 100mm high concrete base. Provide closed spring isolators rated 95% efficiency under each unit.

.6 Supply with each unit, two high pressure metallic hoses, methyl hydrate compatible by unit Manufacturer. Supply similar metallic hose for condensate connection.

.7 Contained within unit enclosure shall be all factory wiring, piping, controls, compressor, and holding charge of R-410A refrigerant. (R-22 is acceptable for units with nominal cooling capacity of 1.5 tons and less).

.8 Factory run-test units in both heating and cooling modes with full water flow.

.9 Unit capable of starting with 4 °C entering air temperature and 4 °C entering water temperature in heating mode with ARI water and airflow rates.

.10 Unit Configuration: Packaged, horizontal type, vertical for HP-H045.

.3 Unit Cabinet:

.1 Fabricated from G-90 galvanized steel, phosphatized, and coated with baked enamel finish.

.2 Insulated sheet metal panel separating fan compartment from compressor compartment.

.3 Removable access panels providing full access to compressor, and control and fan sections without having to remove supply or return ductwork.

.4 Separate openings and knockouts for entrance of line voltage, condensate piping, and low voltage control wiring.

.5 Water connections and electrical knockouts located so as to not interfere with serviceability of unit.

.6 Interior insulated with 25 mm thick, 24 kg per cubic metre density, coated glass fibre insulation, attached with adhesive material.

.7 Fibreglass insulation exposed edges tucked under flanges to prevent introduction of glass fibres into airstream.

.8 Ducted Units: Provide duct flanges for connection of supply and return ductwork, and filter racks.

.9 Horizontal Units: Factory-mounted, heavy steel hanger brackets secured to top of unit complete with rubber isolators to suspend unit from ceiling.

.4 Evaporator Fan:

.1 Double-inlet, double-width, forward-curved fan.

.2 Direct-drive as standard with unit.

.3 Motor:

.1 Totally enclosed and permanently lubricated, with integral overload protection.

.2 Three speed.

.5 Compressor:

.1 Fully hermetic reciprocating or scroll type.

.2 Equipped with oil system, operating oil charge, and motor.

.3 Internal overload and over-temperature protection.

.4 Motor shall be NEMA rated, Class F, suitable for operation in a refrigerant atmosphere.

.5 Reciprocating compressors shall be equipped with crankcase heaters.

.6 Scroll compressors shall have high discharge gas temperature protection.

.7 Compressor assembly shall be installed on rubber vibration isolators.

.6 Refrigerant to Air Coil:

.1 Constructed of aluminum, fins mechanically bonded to internally enhanced seamless copper tubes, with galvanized steel tube sheets.

.2 Condensate Drain Pan: Plastic, extending full length of air coil, insulated, with primary and secondary drain fittings, minimum 20 mm copper drain tube, extending outside unit casing.

.7 Water to Refrigerant Coil:

.1 Co-axial tube-within-a-tube or shell-and-tube water-cooled type.

.2 Supply and return water connections with female NPT copper fittings located outside cabinet for connection to flexible hoses.

.8 Refrigeration Components:

.1 Brass liquid line and suction line service valves with service gauge port connections.

.2 Accumulator.

.9 Controls:

.1 Factory selected, assembled, and tested.

.2 Refrigerant Metering:

.1 Reverse flow bypass metering device with internal check valves.

.2 Heating mode metering device.

.3 Control box within unit cabinet containing 24-volt transformer, 24-volt activated 2- or 3-pole compressor contactor, low voltage terminal junction block.

.4 Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.

.5 Automatic restart on power failure.

.6 Safety lockout if any outdoor unit safety is open.

.7 Start capacitor and relay (single-phase units without scroll compressors).

.8 Safeties:

.1 Reversing valve shall be energized in cooling mode, with "fail-safe" to heating mode.

.2 Circuit-breaker protected control circuit.

.3 High condensing temperature protection.

.4 Compressor motor current and temperature overload protection.

.5 High refrigerant pressure relief.

.6 Low voltage protection.

.7 High voltage protection.

.8 Unit shutdown on high or low refrigerant pressures. Low-pressure switch shall not be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.

.9 Unit shutdown on low water temperature.

.10 Water coil freeze protection (selectable for water or antifreeze).

.11 Air coil freeze protection (check filter switch).

.12 Condensate overflow shutdown.

.13 Automatic intelligent reset. Unit shall automatically reset 5 minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially then permanent lockout will occur.

.14 Ability to defeat time delays for servicing.

.15 Selectable 24-volt or pilot duty dry contact alarm output.

.16 24-volt output to cycle a motorized water valve with compressor contactor.

.10 Filters:

.1 Rack mounted.

.2 25 mm thick strainer type with pleated nonwoven fabric media.

.3 Rated at 30 percent efficiency and 90 percent average arrestance in accordance with ASHRAE 52.

.4 As manufactured by Farr; 30/30.

.11 Accessories: Provide as follows:

.1 Compressor Cycle Delay: Compressor prevented from restarting for a minimum of 5 minutes after shutdown.

.2 Hot Gas Bypass: Cooling capacity modulation with hot-gas solenoid valve and bypass piping on both compressors.

.3 Evaporator Coil Freeze Thermostat: SPST temperature activated switch, shuts down unit upon evaporator freeze-up.

.4 Filter Drier: Liquid line mounted, bi-flow type for heat pumps.

.5 Corrosion Resistant Heat Exchanger: Cupro-nickel heat exchanger, 90 percent copper and 10 percent nickel alloy material.

.6 Insulated Heat Exchanger: Factory blanket insulation cover.

.7 Auxiliary Relays: One or more relays for random-start, alarm signal, or auxiliary dry contact.

.8 Auxiliary Transformer: 24 volt with circuit breaker, minimum 75 VA, for additional power to operate auxiliary devices.

.9 Condenser Specialties:

.1 Flexible Piping Connectors:

.1 Minimum 600 mm long stainless steel braided supply and return water hoses with male NPT brass fittings and a swivel at one end.

.2 Hoses rated at minimum 2068 kPa working pressure.

.10 Acceptable Manufacturers:

.1 Climate Master.

.2 Carrier.

.3 Florida Heat Pump.

2.4 Electrical

.1 General:

.1 Units shall include high and low voltage terminal block connections.

.2 Control voltage to indoor unit fan shall be 24 volts.

.3 Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.

.4 Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit.

.2 Motors:

.1 Unless otherwise stated, electric motors shall comply with the following:

.1 Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.

.2 Enclosure: ODP, unless specified otherwise.

.3 Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

.4 Winding Thermal Protection: Manufacturer's standard.

.5 Space Heater: Manufacturer's standard.

.6 Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer's standard.

.7 Efficiency: In accordance with Section 15010, General Mechanical Provisions.

2.5 Accessories

.1 Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.

.2 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown on drawings.

.3 Anchor Bolts: Type 316 stainless steel, sized by equipment Manufacturer, 12 mm minimum diameter, quantity as recommended by Manufacturer.

2.6 Source Quality Control

.1 Factory Tests:

.1 Direct expansion coils leak tested underwater with 1380 kPa air. Pressure tested to 3100 kPa.

.2 Electric heating coils tested with 2,000-volt dielectric test.

3. EXECUTION

3.1 Installation

.1 Set and install equipment so that equipment is level and properly supported.

.2 Make certain that piping connections to equipment do not cause any strain on equipment.

.3 Make certain that vibration isolation has been installed per Manufacturer's instructions and isolation devices are performing satisfactorily.

.4 Install equipment in accordance with Manufacturer's recommendations, and these Specifications.

.5 Install all safety devices as recommended by Manufacturer and/or required by code in these Specifications.

.6 Initial equipment startup shall be made by an authorized representative of the unit Manufacturer.

.7 Startup: Manufacturer shall provide a factory-trained representative employed by the equipment Manufacturer to perform the following services. Supervision only, of Contractor personnel, will not be acceptable.

.1 Leak test.

.2 Refrigerant pressure test.

.3 Evacuate (if required).

.4 Dehydrate (if required).

.8 Factory Checkout:

.1 Contractor shall secure the services of a factory trained and qualified service engineer employed by the equipment Manufacturer who shall inspect the installation including

external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.

.2 This service engineer shall forward a report in three copies to Contract Administrator when the unit is in safe and proper operating condition. This report shall contain all pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure, and shall list minor discrepancies to be corrected which do not affect safe and reliable operation.

.3 One additional copy of report shall be left in unit control panel. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in the unit control panel at the time of starting.

.9 Locate units to provide access for filter changing; motor, drive, and bearing servicing; and fan shaft and coil removal.

.10 Isolate sheet metal duct connections from all portions of the unit not internally spring-isolated from fans, or other vibrating or rotating equipment.

.11 Inspect internal casing insulation, seal all exposed edges, and butt joints with mastic to ensure insulation will not be loosened during operation.

3.2 Adjusting and Cleaning

.1 Air System Balancing: As specified in Section 15950, HVAC Systems Testing, Adjusting, and Balancing.

.2 Lubricate unsealed bearings prior to startup.

.3 Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

3.3 Filters

.1 Install a complete set of filters in each unit before operating, and leave in place during startup and testing to keep the equipment and ductwork clean.

.2 Install a complete set of new filters at the time of Commissioning as specified in Section 01670, Commissioning.

3.4 Manufacturer’s Services

.1 Provide Manufacturer's services and Certificate of Satisfactory Installation in accordance with the requirements of Section 01650 - Equipment Installation. Manufacturer’s Representative shall provide site support of equipment installations, field inspection of equipment before startup, and the executed copies of Certificate of Satisfactory Installation.

.2 Duration of Training: The training of City's personnel shall be carried out as per Section 01664 - Training.

3.5 Warranty

.1 Furnish Manufacturer's extended warranty, with City named as beneficiary, for a period of 5 years after the date of Total Performance. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

3.6 Supplements

.1 The supplements listed below, following "End Of Section," are a part of this Specification.

.1 15730-01, Water Source Heat Pump (HP) Schedule 1 of 2

.2 15730-02, Water Source Heat Pump (HP) Schedule 2 of 2

END OF SECTION

WATER SOURCE HEAT PUMP (HP) SCHEDULE 1 OF 2
15730-01

EQUIPMENT TAGS	AREA SERVED	FAN DATA			PERFORMANCE DATA												
		CAPACITY		SPEED	COOLING						HEATING	SOURCE SIDE (Water)					
		L/s	E.S.P.	RPM	CAPACITY kW		EAT Deg. C		LAT Deg. C		CAPACITY	FLOW	PD	HEATING Deg. C		COOLING Deg.C	
			Pa		Total	Sensible	DB	WB	DB	WB	kW	L/s	kPa	EWT	LWT	EWT	LWT
HP-H045	Instrumenatioin Repair Shop	509	163	HI	8.4	5.9	26.5	19.1	16.9	14.5	9.1	0.38	15.0	10	8.3	29	36.0
HP-H046	Backup Server Room	401	125	HI	7.3	5.4	13.9	13.9	13.9	12.4	5.7	0.38	15.0	10	10.2	29	35.2
HP-H070	Server Room	755	125	HS HI	13.5	10.0	25.1	17.4	14.1	12.6	15.7	0.57	12.9	10	7.6	29	36.8
HP-H077	Control Room	633	125	HI	10.3	7.7	14.9	14.9	14.9	13.3	12.7	0.52	12.9	10	8.2	29	35.6
HP-H078	Women's Change Room	142	125	HI	2.3	1.6	15.4	15.4	15.4	14.3	2.7	0.14	20.1	10	9.4	29	34.7
HP-H079	Men's Change Room	212	125	MED	3.8	2.4	15.2	15.2	15.2	13.4	4.0	0.17	10.2	10	8.2	29	36.6
HP-H080	Technicians Area	236	125	HI	3.8	3.0	14.5	14.5	14.5	13.1	4.1	0.17	10.2	10	8.2	29	36.6
HP-H081	UPS Room	236	125	HI	3.8	3.0	14.6	14.6	14.6	13.1	4.1	0.17	10.2	10	8.2	29	36.6
HP-H082	Lunch Room	983	125	HS MED	17.4	13.4	13.8	13.8	13.8	12.6	18.7	0.71	15.0	10	8.2	29	36.4
HP-H083	Offices 1-2, 1-3, 1-4 (3rd. Level)	307	125	HS MED	4.9	3.7	15.1	15.1	15.1	13.3	5.6	0.26	8.1	10	8.8	29	35.2
HP-H084	Office No.1-1 (3rd. Level)	142	125	HI	2.1	1.7	15.2	15.2	15.2	13.4	2.5	0.10	13.5	10	8.7	29	36.4
HP-H085	Conference Room	170	125	HI	3.2	2.4	13.1	13.1	13.1	11.9	3.6	0.14	27.3	10	8.3	29	36.9
HP-H086	Stair No. 1	700	125	HS HI	10.5	8.3	15.1	15.1	15.1	13.3	12.9	0.63	18.6	10	8.9	29	34.6

EQUIPMENT TAGS	AREA SERVED	WEIGHT [kg]	ELECTRICAL DATA						ClimateMaster MODEL NUMBER	REMARKS
			POWER V/Ph/Hz	R L A	L R A	F L A	M C A	FUSE SIZE		
HP-H045	Instrumenatioin Repair Shop	122	208/1/60	13.5	61.0	16.7	18.3	30.0	TS030-PSC	Vertical with down discharge
HP-H046	Backup Server Room	120	208/1/60	12.8	60.0	15.7	17.1	25.0	TS024-PSC	
HP-H070	Server Room	189	208/1/60	20.5	109.0	23.5	28.6	45.0	TS048-PSC	
HP-H077	Control Room	188	208/1/60	15.4	83.0	17.5	21.4	35.0	TS042-PSC	
HP-H078	Women's Change Room	51	208/1/60	3.9	22.2	4.7	5.7	15.0	GRH009	
HP-H079	Men's Change Room	67	208/1/60	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H080	Technicians Area	67	208/1/60	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H081	UPS Room	67	208/1/60	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H082	Lunch Room	200	208/3/60	17.6	123.0	22.5	26.9	40.0	TS060-PSC	
HP-H083	Offices 1-2, 1-3, 1-4 (3rd. Level)	115	208/1/60	6.8	38.0	7.8	9.5	15.0	TS018-PSC	
HP-H084	Office No.1-1 (3rd. Level)	51	208/1/60	3.9	22.2	4.7	5.7	15.0	GRH009	
HP-H085	Conference Room	55	208/1/60	5.3	27.9	6.1	7.4	15.0	GRH012	
HP-H086	Stair No. 1	188	208/1/60	15.4	83.0	17.5	21.4	35.0	TS042-PSC	

LEGENDS:

EAT ENTERING AIR TEMPERATURE
LAT LEAVING AIR TEMPERATURE
EWT ENTERING WATER TEMPERATURE
LWT LEAVING WATER TEMPERATURE
DB DRY BULB
WB WET BULB
ESP EXTERNAL STATIC PRESSURE
PD PRESSURE DROP
RLA RUNNING LOAD AMP
LRA LOCK ROTOR AMP
FLA FULL LOAD AMPS
MCA MINIMUM CIRCUIT AMPS

WATER SOURCE HEAT PUMP (HP) SCHEDULE 2 OF 2
15730-02

EQUIPMENT TAGS	AREA SERVED	FAN DATA			PERFORMANCE DATA											
		CAPACITY		Fan	COOLING						HEATING	SOURCE SIDE (Water)				
		L/s	E.S.P.	Speed	CAPACITY kW		EAT Deg. C		LAT Deg. C		CAPACITY	FLOW	DELTA P	HEATING Deg. C		COOLING Deg.C	
			Pa		Total	Sensible	DB	WB	DB	WB	kW	L/s	kPa	EWT	LWT	EWT	LWT
HP-H087	Lab	245	125	HI	3.9	2.7	14.9	14.9	14.9	13.7	4.1	0.17	10.2	10	8.2	29	36.6
HP-H088	Offices 2,3,44	241	125	HI	4.0	2.7	15.7	15.7	15.7	14.7	4.1	0.17	10.2	10	8.2	29	36.6
HP-H089	Reception	377	125	HI	7.2	4.8	14.5	14.5	14.5	12.5	5.6	0.38	15.0	10	10.2	29	35.2
HP-H090	Offices 3,6-9	142	125	HI	2.2	1.7	15.2	15.2	15.2	13.4	2.6	0.11	15.3	10	8.9	29	35.8
HP-H091	Conference No.1	369	125	HI	7.3	5.4	13.9	13.9	13.9	12.4	6.3	0.38	15.0	10	18.2	29	35.2
HP-H092	Conference No.2	236	125	HI	3.8	3.0	14.5	14.5	14.5	13.1	4.8	0.17	10.2	10	15.7	29	36.6
HP-H093	Office No. 2 and General Office	317	125	HS HI	4.9	3.7	14.3	14.3	14.3	12.8	6.6	0.26	8.1	10	16.3	29	35.2
HP-H094	Office No. 1	142	125	HI	2.2	1.7	15.2	15.2	15.2	13.4	2.9	0.10	13.5	10	16.1	29	36.4
HP-H095	Offices 4-5 (2nd. Level)	165	125	HI	3.3	2.5	13.2	13.2	13.2	12.3	4.3	0.14	27.3	10	15.7	29	36.9
HP-H096	Lobby & Vestibule Area	389	125	HS MED	7.3	5.2	13.8	13.8	13.8	12.4	5.7	0.38	15.0	10	10.2	29	35.2
HP-H097	Elevator Machine Room Cooling	516	125	HS HI	8.2	6.2	15.1	15.1	15.1	13.3	9.2	0.38	15.0	10	8.3	29	36.0
HP-H098	Corridor No. 3	106	125	HI	1.8	0.8	18.5	18.5	18.5	16.6	2.0	0.09	9.0	10	9.1	29	35.4
HP-H099	Library	142	125	HI	2.2	1.7	15.1	15.1	15.1	13.2	3.1	0.14	20.1	10	17.1	29	34.7

EQUIPMENT TAGS	AREA SERVED	WEIGHT [kg]	ELECTRICAL DATA						ClimateMaster MODEL NUMBER	REMARKS
			POWER V/Ph/Hz	R L A	L R A	F L A	M C A	FUSE SIZE		
HP-H087	Lab	67	208/60/1	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H088	Offices 2,3,44	67	208/60/1	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H089	Reception	120	208/60/1	12.8	60.0	15.7	17.1	25.0	TS024-PSC	
HP-H090	Offices 3,6-9	51	208/60/1	3.9	22.2	4.7	5.7	15.0	GRH009	
HP-H091	Conference No.1	120	208/60/1	12.8	60.0	15.7	17.1	25.0	TS024-PSC	
HP-H092	Conference No.2	67	208/60/1	6.1	29.0	7.1	8.6	15.0	GRH015	
HP-H093	Office No. 2 and General Office	115	208/60/1	6.8	38.0	7.8	9.5	15.0	TS018-PSC	
HP-H094	Office No. 1	51	208/60/1	3.9	22.2	4.7	5.7	15.0	GRH009	
HP-H095	Offices 4-5 (2nd. Level)	55	208/60/1	5.3	27.9	6.1	7.4	15.0	GRH012	
HP-H096	Lobby & Vestibule Area	120	208/60/1	12.8	60.0	15.7	17.1	25.0	TS024-PSC	
HP-H097	Elevator Machine Room Cooling	122	208/60/1	13.5	61.0	16.7	18.3	30.0	TS030-PSC	
HP-H098	Corridor No. 3	51	208/60/1	2.9	17.7	3.2	3.9	15.0	GRH006	
HP-H099	Library	51	208/60/1	3.9	22.2	4.7	5.7	15.0	GRH009	

LEGENDS:

EAT ENTERING AIR TEMPERATURE
LAT LEAVING AIR TEMPERATURE
EWT ENTERING WATER TEMPERATURE
LWT LEAVING WATER TEMPERATURE
DB DRY BULB
WB WET BULB
ESP EXTERNAL STATIC PRESSURE
PD PRESSURE DROP
RLA RUNNING LOAD AMP
LRA LOCK ROTOR AMP
FLA FULL LOAD AMPS
MCA MINIMUM CIRCUIT AMPS

TERMINAL HEAT TRANSFER UNITS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 CGA.

.2 AMCA: Bulletin 300.

.3 ASHRAE: 90.1, Energy Standard for Building Except Low-Rise Residential Buildings.

.4 ASTM: A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

.5 NFPA:

.1 54, National Fuel Gas Code.

.2 70, NEC.

.3 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.6 SMACNA: Ducted Electric Heat Guide for Air Handling Systems.

.7 ULC: Product Directories.

.8 CSA:

.1 B149.1, Natural Gas and Propane Installation Code

.2 C22.1, Canadian Electrical Code

.9 Provincial Gas Code.

1.2 Submittals

.1 Action Submittals:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.

.2 Manufacturer’s standard finish color selection for cabinet finishes.

.3 Performance Data, including sound power level data (ref. 10 to minus 12 watts) at design operating point, shall be based on AMCA Bulletin 300, Setup No. 1.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of equipment and materials prior to installation.

.2 Operation and Maintenance Data: As specified in Section 01730, Operation and Maintenance Manuals.

.3 Certificate of Satisfactory Installation, Form 102, in accordance with Section 01650, Equipment Installation.

1.3 Quality Assurance

.1 Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90A.

2. PRODUCTS

2.1 Supplements

.1 See supplements to this section for additional product information.

2.2 Gas-Fired Unit Heaters, GUH

.1 Characteristics:

.1 Separated combustion with type 316 Stainless steel heat exchanger.

.2 Natural gas-fired burner.

.3 Steel cabinet finished with baked enamel paint.

.4 Horizontal discharge with face louvers and diffuser vanes adjustable for both horizontal and vertical blow.

.5 Direct-drive motor of shaded pole design with oil-lubricated sleeve bearings and built-in thermal overload protection.

.6 Nonferrous multiblade propeller fan.

.7 CGA certified.

.8 Fan controls.

.9 Automatic gas valve.

.10 Electronic ignition.

.11 Gas pressure regulator.

.12 Manual shutoff valve.

.13 High-limit switch.

.14 Flue vent fan.

.15 Concentric adaptor**.**

.16 Built–in disconnect switch, 20A at 115 V rating.

.17 Inlet Air guard and screened exhaust cap for horizontal venting configuration and exhaust terminal and combustion air inlet for vertical venting configuration.

.2 Acceptable Manufacturers:

.1 Reznor; Model UDAS.

.2 Trane; Model GAND.

2.3 Electric Radiant Heaters, ERH

.1 Characteristics:

.1 Electric infrared radiant heater with single tubular element

.2 Extruded aluminum, anodized and chemically brightened reflectors

.3 Swivel bracket and set screw adjustment

.4 Power supply: 600 V, single phase, 60 Hz.

.5 Finish: Manufacturer's standard.

.2 Acceptable Manufacturers:

.1 CCI Thermal Caloritech; OKB Series.

2.4 Electric Unit Heaters, EUH

.1 Housing

.1 Carbon steel

.2 Heating Element

.1 Stainless steel (2-30 kW).

.3 Mounting

.1 Bracket and hardware for ceiling or wall mounting.

.4 Grilles

.1 Adjustable discharge louvers

.5 Guard

.1 Fan guard

.6 Controls

.1 120 V control transformer

.2 Dual manual and auto reset temperature cutout

.3 Fan delay relay

.4 Controlling magnetic contactors

.5 Power Disconnect, 3P, 20A, 600V

.6 Safety contactor

.7 Terminal blocks for field wiring

.8 Motor contactor

.9 Control enclosure to suit

.7 Finish

.1 Standard factory finish

.8 Acceptable Manufacturers:

.1 Chromalox, Type EUH.

.2 Ouellet.

2.5 Electric Convectors EC

.1 Cabinet and General Arrangement:

.1 Slope top design.

.2 2.0 mm thick (14-gauge) extruded aluminum front and top.

.1 Satin coat steel back and bottom.

.2 Removable endcaps.

.2 Heating Elements

.3 Aluminum finned stainless steel tubular element.

.4 Floating element suspension.

.3 Controls: Built-in thermostat.

.4 Built-in disconnect switch, rated 600 V, 25A

.5 Acceptable Manufacturers:

.1 Chromalox, AS8 Signature II Series.

.2 Ouellet.

2.6 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each piece of equipment in a readily visible location. Plate shall bear 10 mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.7 Source Quality Control

.1 Factory Tests and Adjustments**:** Test equipment actually furnished.

3. EXECUTION

3.1 Installation

.1 Gas-Fired and Electric Unit Heaters:

.1 Install in accordance with manufacturer's recommendations and applicable gas codes.

.2 Mount bottom of unit at 2.4 m above the floor, except where noted otherwise on Drawings.

.3 Provide a shut-off ball valve, suitable for natural gas application, and a drip leg at each connection to gas-fired unit heater.

.2 Venting and Combustion Air for Gas Fired Unit Heaters:

.1 Supply and install in accordance with manufacturer's recommendations.

.2 Install in accordance with requirements of "National Fuel Gas Code" (NFPA 54) and Manitoba Gas Notice.

.3 Provide single-wall stainless steel pipes of minimum 0.48 mm thickness (26 gauge) for vent pipe and combustion air pipe between the heater and the concentric adapter.

3.2 Manufacturer's Services

.1 Provide Manufacturer's Representative at Site in accordance with Section 01650, Equipment Installation, for installation assistance, inspection and certification, equipment testing, startup assistance, and training of City's personnel for specified equipment.

3.3 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.1 15760-01 Gas Fired Unit Heater (GUH) Schedule.

.2 15760-02 Electric Unit Heater (EUH) Schedule.

.3 15760-03 Electric Radiant Heater (ERH) Schedule

.4 15760-04 Electric Convectors (EC) Schedule.

END OF SECTION

GAS FIRED UNIT HEATER (GUH) SCHEDULE
15760-01

EQUIPMENT TAGS	AREA SERVED	FAN DATA		MOTOR DATA				CAPACITY		PHYSICAL DIMENSIONS				REZNOR MODEL NO.	REMARKS
		CAPACITY	SPEED					INPUT	OUTPUT	WEIGHT	DIMENSIONS mm				
		L/s	RPM	W	RPM	VOLT	PH	kW	kW	kg	L	W	H		
GUH-H001	Filter Gallery (East)	363	1550	22	1550	115	1	17.6	14.6	34	686	676	384	UDAS-60	
GUH-H002	Filter Gallery (Central)	363	1550	22	1550	115	1	17.6	14.6	34	686	676	384	UDAS-60	
GUH-H003	Filter Gallery (West)	363	1550	22	1550	115	1	17.6	14.6	34	686	676	384	UDAS-60	
GUH-H051	DAF Gallery (West side)	634	1050	186	1050	115	1	30.8	25.5	54	727	676	587	UDAS-100	
GUH-H052	DAF Gallery (central)	634	1050	186	1050	115	1	30.8	25.5	54	727	676	587	UDAS-100	
GUH-H053	DAF Gallery (East side)	634	1050	186	1050	115	1	30.8	25.5	54	727	676	587	UDAS-100	
GUH-H055	DAF Gallery (Overhead door)	297	1550	22	1550	115	1	13.2	10.9	31	660	676	308	UDAS-45	
GUH-H011	Mechanical Room No. 2	906	1050	186	1050	115	1	44.0	36.5	93	1067	970	511	UDAS-150	
GUH-H012	Mechanical Room No. 2	906	1050	186	1050	115	1	44.0	36.5	93	1067	970	511	UDAS-150	
GUH-H021	Access Corridor No. 5	297	1550	22	1550	115	1	13.2	10.9	31	660	676	308	UDAS-45	
GUH-H022	Access Corridor No. 6	297	1550	22	1550	115	1	13.2	10.9	31	660	676	308	UDAS-45	
GUH-H034	Mechanical Room No. 3	297	1550	22	1550	115	1	13.2	10.9	31	660	676	308	UDAS-45	
GUH-H035	Mechanical Room No. 3	297	1550	22	1550	115	1	13.2	10.9	31	660	676	308	UDAS-45	
GUH-H036	Receiving Area	363	1550	22	1550	115	1	17.6	14.6	34	686	676	384	UDAS-60	
GUH-H071	Mechanical Room No. 4	215	1550	15	1550	115	1	8.8	7.2	29	660	676	308	UDAS-30	

REMARKS:

ELECTRIC UNIT HEATER (EUH) SCHEDULE
15760-02

EQUIPMENT TAGS	AREA SERVED	AIRFLOW	CAPACITY			PHYSICAL DIMENSIONS				CHROMALOX MODEL NO.	REMARKS
		L/s				WEIGHT	DIMENSIONS mm				
			kW	VOLT	PH	kg	L	W	H		
EUH-H061	Valve Chamber	165	3.0	575	3	18	330	330	495	EUH03B83CT	
EUH-H062	RW Pump Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	
EUH-H063	Main Floor Electrical Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	
EUH-H031	Third Floor Electrical Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	
EUH-H064	RWP Penthouse Mech Rm	165	3.0	575	3	18	330	330	495	EUH03B83CT	
EUH-H065	Fire Pump Room	283	10.0	575	3	22	330	330	495	EUH10B84CT	
EUH-H032	Recycle Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	
EUH-H033	Waste Storage Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	
EUH-H034	Blower Room	165	5.0	575	3	18	330	330	495	EUH05B84CT	

REMARKS:

ELECTRIC RADIANT HEATER (ERH) SCHEDULE
15760-03

EQUIPMENT TAGS	AREA SERVED	ELECTRICAL DATA			PHYSICAL DATA			CCI THERMAL MODEL NUMBER	REMARKS
		kW	VOLT	PH	WEIGHT [kg]	HEATED LENGTH [mm]	OVERALL LENGTH [mm]		
ERH-H013A	Mechanical Rm No.2 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H013B	Mechanical Rm No.2 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H013C	Mechanical Rm No.2 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H013D	Mechanical Rm No.2 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H014	Mechanical Rm No.2 Combustion Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H015A	Mechanical Rm No.2 South Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H015B	Mechanical Rm No.2 South Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H015C	Mechanical Rm No.2 South Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H015D	Mechanical Rm No.2 South Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H016	Residuals Handling Area Relief Air Plenum Heater	0.95	120	1	2.3	508	800	OKB299C6	
ERH-H038A	Mechanical Rm No.3 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H038B	Mechanical Rm No.3 North Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H039	Mechanical Rm No.3 Combustion Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H040	Mechanical Rm No.3 South Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H071	Mechanical Room No.4 Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H072	Mechanical Room No.4 Combustion Air Plenum Heater	0.95	120	1	2.3	508	800	OKB299C6	
ERH-H066A	Mechanical Room No.1 Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H066B	Mechanical Room No.1 Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	
ERH-H066C	Mechanical Room No.1 Air Plenum Heater	3.80	600	1	5.3	1575	1867	OKB713C6	

REMARKS:

ELECTRIC CONVECTORS (EC) SCHEDULE
15760-04

EQUIPMENT TAGS	AREA SERVED	CAPACITY	PHYSICAL DATA		CHROMALOX MODEL NUMBER	REMARKS	EQUIPMENT TAGS	AREA SERVED	CAPACITY	PHYSICAL DATA		CHROMALOX MODEL NUMBER	REMARKS
			WEIGHT	OVERALL LENGTH						WEIGHT	OVERALL LENGTH		
		[kW]	[kg]	[mm]					[kW]	[kg]	[mm]		
EC-H001	Stair No. 5 (NE) at EL 237.57	0.75	9.5	921	AS8F307		EC-H070	Lunch Room Rm	1.00	12.0	1223	AS8F410	(1)
EC-H002	Stair No. 6 (NE) at EL 237.17	0.75	9.5	921	AS8F307		EC-H071	Lunch Room Rm	1.00	12.0	1223	AS8F410	(1)
EC-H011	Stair No. 4 (E) at EL 237.17	1.00	12.0	1223	AS8F410		EC-H072	Office No. 4	1.00	12.0	1223	AS8F410	(1)
EC-H021	Stair No. 9 at EL 245	1.00	12.0	1223	AS8F410		EC-H073	Office No. 3	1.00	12.0	1223	AS8F410	(1)
EC-H037	Stair No. 7 (East) EL 236.17	0.75	9.5	921	AS8F307		EC-H074	Office No. 2	1.00	12.0	1223	AS8F410	(1)
EC-H038	Maint. General Storage	0.50	7.0	616	AS8F205		EC-H075	Office No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H039	Maint. Office	0.50	7.0	616	AS8F205	(1)	EC-H076	Office No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H040	Maint. Kitchenette	0.50	7.0	616	AS8F205	(1)	EC-H077	Women's Washroom	0.50	7.0	616	AS8F205	
EC-H041	Maint. Washroom EL 245	0.50	7.0	616	AS8F205		EC-H078	Women's Washroom	1.00	12.0	1223	AS8F410	
EC-H042	Maint. Vestibule No. 5 EL. 245	0.50	7.0	616	AS8F205		EC-H079	Men's Washroom	0.50	7.0	616	AS8F205	
EC-H043	Stair No. 8 (Roof Level)	1.00	12.0	1223	AS8F410		EC-H080	Reception Area	1.00	12.0	1223	AS8F410	(1)
EC-H054	Stair No. 2 (West) EL 236.67	0.75	9.5	921	AS8F307		EC-H081	Reception Area	1.00	12.0	1223	AS8F410	(1)
EC-H060	Control Room	1.00	12.0	1223	AS8F410	(1)	EC-H082	Reception Area	1.00	12.0	1223	AS8F410	(1)
EC-H061	Control Room	1.00	12.0	1223	AS8F410	(1)	EC-H083	Reception Area	1.00	12.0	1223	AS8F410	(1)
EC-H062	Control Room	1.00	12.0	1223	AS8F410	(1)	EC-H084	General Office No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H063	Control Room	1.00	12.0	1223	AS8F410	(1)	EC-H085	Office No. 2	1.00	12.0	1223	AS8F410	(1)
EC-H064	Night Room	0.50	7.0	616	AS8F205	(1)	EC-H086	Office No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H065	Server Room	1.00	12.0	1223	AS8F410	(1)	EC-H087	Office No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H066	Technician Area	1.00	12.0	1223	AS8F410	(1)	EC-H088	Vestibule	1.00	12.0	1223	AS8F410	(1)
EC-H067	Technician Area	1.00	12.0	1223	AS8F410	(1)	EC-H089	Stair No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H068	Lunch Room Rm	1.00	12.0	1223	AS8F410	(1)	EC-H090	Stair No. 1	1.00	12.0	1223	AS8F410	(1)
EC-H069	Lunch Room Rm	1.00	12.0	1223	AS8F410	(1)	EC-H091	Lobby	1.00	12.0	1223	AS8F410	(1)

REMARKS:

(1) Built-in Thermostat

(2) Electrical power for all heat is 120-1ph-60Hz

METAL DUCTWORK AND ACCESSORIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 AMCA: 500, Test Methods for Louvers, Dampers and Shutters.

.2 ASHRAE Handbook.

.3 INDA: IST 80.6, Water Resistance (Hydrostatic Pressure Test).

.4 ASTM:

.1 A36/A36M, Standard Specification for Carbon Structural Steel.

.2 A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

.3 A123/A123M Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.4 A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.5 A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

.6 A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.

.7 A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.

.8 A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.9 A563/A563M Standard Specification for Carbon and Alloy Steel Nut.

.10 A568/A568M, Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.

.11 A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.12 A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment.

.13 A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

.14 A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

.15 B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

.16 C916, Standard Specification for Adhesives for Duct Thermal Insulation.

.17 C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).

.18 C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.

.19 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.20 E96, Standard Test Methods for Water Vapor Transmission of Materials.

.5 NFPA:

.1 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.2 90B Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.3 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

.4 259, Standard Test Method for Potential Heat of Building Materials.

.6 SMACNA:

.1 Duct Construction Standards.

.2 Guidelines for Seismic Restraints of Mechanical Systems.

.3 Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

.4 HVAC Air Duct Leakage Test Manual.

.7 UL:

.1 181, Standard for Safety Factory-Made Air Ducts and Connectors.

.2 555, Standard for Safety Fire Dampers.

.3 555C, Standard for Safety Ceiling Dampers.

.4 555S, Standard for Safety Smoke Dampers.

.8 Underwriters Laboratories of Canada (ULC).

.9 National Fire Code of Canada.

.10 National Building Code of Canada.

1.2 Submittals

.1 Action Submittals:

.1 Ductwork Accessories:

.1 Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes for the following items:

.1 Duct liner.

.2 Sealing materials.

.3 Dampers; include leakage, pressure drop, and maximum back pressure data.

.4 Duct-mounted access panels and doors.

.5 Insulated flexible ducts.

.6 Sheet metal fasteners.

.2 Duct Fabrication Drawings:

.1 Drawn after actual job measurements are obtained.

.2 Drawn to a scale not smaller than 1:50, on drawing sheets same size as Contract Drawings, detailing:

.1 Fabrication, assembly, and installation details including plans, elevations, sections, details of components, and attachments to other work.

.2 Duct layout, indicating pressure classifications, and sizes in plan view.

.3 For materials handling exhaust duct systems, indicate classification of materials handled.

.4 Duct material and thickness.

.5 Fittings and volume control damper installation (both manual and automatic) details.

.6 Reinforcing details and spacing.

.7 Seam and joint construction details.

.8 Penetrations through fire-rated and other partitions.

.9 Duct accessories and control devices such as automatic dampers, airflow monitors, terminal units, smoke detectors, regulators, air distribution devices, etc.

.10 Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

.11 Fire and smoke damper installations, including sleeves and duct-mounted access door and panel installation.

.12 Coordination with ceiling suspension members.

.13 Spatial coordination with other systems installed in same space with duct systems.

.14 Coordination of ceiling- and wall-mounted access doors and panels required for access to dampers and other operating devices.

.15 Coordination with ceiling-mounted lighting fixtures, air outlets, and inlets.

.3 Shop Drawings shall indicate the coordination of ductwork with sprinkler piping and other mechanical and electrical services, and equipment installed under Division 15, MECHANICAL, and Division 16, ELECTRICAL.

1.3 Informational Submittals:

.1 Sound Attenuators Certified Test Data:

.1 Dynamic insertion loss.

.2 Self-noise power levels.

.3 Static pressure loss.

.4 Dimensions and weights.

1.4 Quality Assurance

.1 Industry Standards:

.1 Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA duct construction standard relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.

.2 Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.

.3 NFPA Compliance: NFPA 90A and NFPA 90B.

.2 Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

.3 The Contractor shall provide on request the following information:

.1 Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.

.2 Laboratory performance data for fittings, including zero-length dynamic losses.

.4 The Subcontractor shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Work.

.5 Changes or alterations to layout or configuration of duct system shall be:

.1 Specifically approved in writing by Contract Administrator.

.2 Proposed layout shall provide original design results, without increasing system total pressure.

1.5 Delivery, Storage and Handling

.1 Protect ductwork from dirt, water, and debris. During storage on Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

.2 Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

.3 Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

.4 Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

2. PRODUCTS

2.1 General

.1 Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

.2 Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

.3 Ductwork Interior Surfaces:

.1 Smooth.

.2 No sheet metal parts, tabs, angles, screws, or other items may project into air ducts, unless otherwise specified.

.3 Seams and joints shall be external.

2.2 Sheet Metal Materials

.1 Construct metal duct systems from materials as indicated in Ductwork Schedule, 15810-01.

.2 Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

.3 Galvanized Steel Ductwork:

.1 Comply with ASTM A653/A653M.

.2 Galvanized steel sheet, lock forming quality, zinc coating designation G90 in conformance with ASTM A90/A90M.

.3 Sheet metal shall bear LFQ and G90 marks.

.4 Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.

.5 Provide sheet metal packaged and marked as specified in ASTM A700.

.4 Aluminum Ductwork:

.1 Comply with ASTM B209.

.2 Aluminum Sheet: Alloy 3003-H14, unless indicated otherwise.

.3 Aluminum Connectors and Bar Stock: Alloy 6061-T6 or approved equal.

.5 Stainless Steel Ductwork:

.1 Comply with ASTM A167, A176, A240/A240M, and ASTM A480.

.2 Stainless Steel Sheet: Type 304, unless indicated otherwise.

.3 Gauge shall comply with SMACNA manual, unless specified otherwise.

.4 Finish: No. 2 B (cold-rolled, bright) finish, except as otherwise noted.

.5 With No.4 finish on exposed surface for ducts exposed to view.

.6 Exposed Ductwork: Where ductwork is exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections, including those which would impair painting.

.7 Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

2.3 Duct Sealing Materials

.1 General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

.2 Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

.3 Solvent-Based Sealants:

.1 Ultraviolet light resistant.

.2 Mildew resistant.

.3 Flashpoint: Greater than 21 ^{o}C, SETA CC.

.4 Acceptable Manufacturers:

.1 Hardcast, Inc.; Versagrip 102.

.2 Rectorseal; AT-33.

2.4 Firestopping

.1 Firestopping shall be by Others.

2.5 Ductwork Fasteners

.1 General:

.1 Rivets, bolts, or sheet metal screws.

.2 Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

.2 Self-Drilling Screws:

.1 Galvanized Steel Ductwork System: Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

.2 Aluminum Ductwork System:

.1 Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel, complete with bonded metal and fibre washer for dielectric separation.

.2 Manufacturers:

.1 DB Building Fasteners Inc., Santa Fe Springs, CA.

.2 Clark Craft Fasteners, Tonawanda, NY.

.3 UCAN Fastening Products.

.3 Stainless Steel Ductwork System:

.1 Sheet metal screws shall be HWH TEKS® self-drilling type, formed from heat-treated Marutex® stainless steel with strength of Type 410 stainless steel and corrosion resistance of Type 304 stainless steel.

.2 Manufacturers:

.1 DB Building Fasteners Inc., Santa Fe Springs, CA.

.2 Clark Craft Fasteners, Tonawanda, NY.

.3 UCAN Fastening Products.

2.6 Ductwork Pressure Class

.1 Construct duct systems to pressure classifications indicated in as follows:

.1 Supply Ducts: 750 Pa.

.2 Return Ducts: 500 Pa, negative pressure.

.3 Exhaust Ducts: 500 Pa, negative pressure.

.2 Where no specific duct pressure designations are indicated in Specifications or on Drawings, 500 Pa pressure class shall be basis of Contract.

2.7 Rectangular Ductwork

.1 Fabricate rectangular ducts in accordance with SMACNA Rectangular Industrial Duct Construction Standards, unless specified otherwise.

.2 Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 480 mm and larger and are 0.95 mm thick (20-gauge) or less, with more than 1.0 square metre of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

.3 Air Handling Unit Discharge Ductwork: Ductwork extending from air handling units up to and including first elbow or terminal tap shall be constructed of 1.6 mm thick (16-gauge), minimum.

2.8 Rectangular Ductwork Fittings

.1 Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA Rectangular Industrial Duct Construction Standards.

.2 Elbows:

.1 Fit square-turn elbows with vane side rails.

.2 Shop fabricate double-blade turning vanes of same material as ductwork.

.3 Fabricate with equal inlet and outlet.

.4 Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

.5 Acceptable Manufacturers:

.1 Elgen; All-Tight.

.2 Duro-Dyne; Type TR.

2.9 Rectangular Ductwork Insulation Liner

.1 Location: Provide ductwork with internal insulation liner where indicated on Drawings or in Ductwork Schedule, 15810-01.

.2 Material:

.1 Fibreglass, nominal 24.0 kg/m^3 density liner, K factor 0.035 maximum at 24 ^{o}C mean, black composite coated surface exposed to airstream to prevent erosion of glass fibres, for temperatures to 121 ^{o}C.

.2 Liquid water repellency rating not less than four when tested in accordance with INDA IST 80.6.

.3 Potential heat value not exceeding 2250 watt hr per kg when tested in accordance with NFPA 259 and meeting classification of "Limited Combustible" as defined by NFPA 90A.

.4 Maximum rated velocity not less than 30 m/s when tested in accordance with ASTM C1071.

.5 Resistant to microbial growth using a "no growth criteria" when tested in accordance with ASTM C1139.

.6 Acceptable Manufacturers:

.1 CertainTeed; Toughgard.

.2 Schuller (Manville); Linacoustic.

.3 Knauf; Duct Liner M.

.7 Thickness: Minimum 25 mm or greater thickness where indicated on Drawings or in Ductwork Schedule.

.8 Liner Adhesive: In accordance with NFPA 90A and ASTM C916.

.9 Mechanical Fasteners:

.1 Same material as ductwork, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.

.2 Provide fasteners that do not damage liner when applied as recommended by manufacturer, that do not cause leakage in duct, and will indefinitely sustain 223 N tensile dead load test perpendicular to duct wall.

.3 Fastener Pin Length: As required for thickness of insulation and without projecting more than 3 mm into airstream.

.4 Adhesive for Attachment of Mechanical Fasteners: In accordance with Fire Hazard Classification of duct liner system.

.10 Liner Application:

.1 Ductwork liner shall be applied at time of ductwork manufacture in an approved sheet metal workshop.

.2 Adhere single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

.1 Apply coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

.2 Butt transverse joints without gaps and coat joint with adhesive.

.3 Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

.3 Longitudinal Joints:

.1 Shall not occur except at corners of ducts, unless size of duct and standard liner product dimensions make longitudinal joints necessary.

.2 Apply adhesive coating on longitudinal seams in ducts exceeding 12.5 m/s air velocity.

.4 Secure liner with mechanical fasteners 102 mm from corners and at intervals not exceeding 305 mm transversely around perimeter, at 76 mm from transverse joints, and at intervals not exceeding 457 mm longitudinally.

.5 Secure transversely oriented liner edges facing airstream with metal nosing that are either channel or "Z" profile or are integrally formed from duct wall at the following locations:

.1 Fan discharge.

.2 Intervals of lined duct preceding unlined duct.

.3 Upstream edges of transverse joints in ducts.

.6 Seal insulation edges.

.7 Repair abrasions or tears with mastic.

2.10 Rigid Round Ductwork

.1 Construct rigid round ducts in accordance with SMACNA Round Industrial Duct Construction Standards, unless specified otherwise.

.2 Basic Round Diameter: As used in this Article, is diameter of size of round duct that has circumference equal to perimeter of a given size of flat oval duct.

.3 Where space limitations prevent use of round duct or where shown on Drawings, provide ductwork of flat oval construction.

.4 Fabricate round ducts with spiral seam construction, except where diameters exceed 1800 mm. Fabricate ducts having diameters greater than 1800 mm with longitudinal butt-welded seams.

.5 Single Wall Ductwork: Unless otherwise indicated, rigid round shall be of single wall construction.

2.11 Rigid Round Ductwork Fittings

.1 Construct rigid round ductwork fittings in accordance with SMACNA Round Industrial Duct Construction Standards, unless otherwise specified.

.2 90-Degree Tees, Laterals, and Conical Tees: Fabricate to conform to SMACNA manual with metal thicknesses specified for longitudinal seam straight duct.

.3 Diverging Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

.4 Elbows:

.1 Fabricate in stamped (die-formed), pleated, or segmented (gored) construction 1.5 times elbow diameter. Two piece segment elbows are not allowed, except with turning vanes.

.2 Segmented Elbows: Fabricate with welded construction.

.3 Round Elbows 200 mm and Smaller:

.1 Stamped elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 ^{o}Configuration.

.2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 90 and 115 mm) elbows with segmented construction.

.4 Round Elbows 225 mm Through 350 mm:

.1 Segmented or pleated elbows for 30, 45, 60, and 90 degrees.

.2 Fabricate nonstandard bend angle configurations or nonstandard sized (e.g., 240 and 265 mm) elbows with segmented construction.

2.12 Insulated Flexible Duct

.1 Fabricate in accordance with:

.1 UL 181, Class 1.

.2 NFPA 90A and NFPA 90B.

.2 Construction:

.1 Outer Jacket: Fire retardant reinforced aluminum vapor barrier jacket with reinforced cross-hatched scrim having a permeance of not greater than 0.1 perm when tested in accordance with ASTM E96, Procedure A.

.2 Inner Liner: Tri-laminate of aluminum foil, fibreglass, and aluminized polyester.

.3 Reinforcing: Galvanized steel wire helix, mechanically locked to and encapsulated by inner liner fabric.

.4 Insulation:

.1 Factory insulated with fibreglass insulation.

.2 RSI – 1.06 minimum at a mean temperature of 24 ^{o}C.

.5 Internal Working Pressure: Rating shall be minimum 1500 Pa positive and 1000 Pa negative, with bursting pressure of at least 2-1/2 times working pressure.

.6 Air Velocity Rating: 20 m/s, minimum.

.3 Environment: Suitable for continuous operation at temperature range of minus 29 ^{o}C to plus 121 ^{o}C.

.4 Acceptable Manufacturers:

.1 Flexmaster; Type T/L-A.

2.13 Ductwork Hangers and Supports

.1 General:

.1 Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.

.2 Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.

.3 Wire hangers are not acceptable.

.4 Hanger Spacing:

.1 Ducts Up to 1500 mm in Largest Dimension: 3.0 m, maximum.

.2 Ducts Over 1525 mm in Largest Dimension: 2.4 m, maximum.

.2 Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

.1 Galvanized Steel Ductwork:

.1 Indoors: Carbon steel, zinc electroplated.

.2 Outdoors: Carbon steel, hot-dipped galvanized after fabrication.

.2 Aluminum Ductwork Indoors and Outdoors: Carbon steel, hot-dipped galvanized after fabrication.

.3 Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

.3 Building Attachments:

.1 Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.

.2 Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 100 mm thick.

.3 Upper Attachment (Concrete):

.1 Drive pin fastener and expansion nail anchor may be used for ducts up to 450 mm maximum dimension.

.2 Threaded stud fastener may be used for ducts up to 900 mm maximum dimension.

.3 Concrete attachments shall be made of steel.

.4 Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

2.14 Flexible Connections

.1 Materials:

.1 Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

.2 Outdoor flexible connectors coated with Hypalon for UV protection.

.2 Metal Edged Connectors:

.1 Construct from same material as ductwork, unless otherwise noted.

.2 Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.

.3 Standard Metal Edged Connectors: Factory fabricated with strip of fabric 90 mm wide attached to two strips of 70 mm wide sheet metal.

.4 Extra Wide Metal Edged Connectors: Factory fabricated with strip of fabric 146 mm wide attached to two strips of 70 mm wide sheet metal.

.5 Transverse Metal Edged Connectors: Factory fabricated with strip of fabric 90 mm wide attached to two strips of 111 mm wide sheet metal.

.3 Acceptable Manufacturers:

.1 Duro-Dyne; Durolon.

.2 Dynair.

.3 Papco Industries Inc.

2.15 Ceilings Access Doors

.1 Ceiling access doors shall be by Others. Coordinate exact location and dimensions as required.

2.16 Duct Inspection Doors

.1 General:

.1 Insulated, gasketed, and at least 375 mm by 375 mm when duct dimensions are large enough.

.2 On ductwork where largest side dimension is less then 400 mm, furnish inspection doors at least 200 mm by 200 mm.

.3 Complete with necessary hardware.

.4 Fabricated of same material as ductwork or galvanized steel for fibreglass ductboard.

.2 Round Spin-in Type Access Doors:

.1 Size: 450 mm and 600 mm diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.

.2 Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.

.3 Casing and Plenum Access Doors:

.1 Size: 1425 mm high by 600 mm wide minimum where possible.

.2 Complete with hardware, hinges, seals, and latch handles.

.4 Manufacturers:

.1 Duro-Dyne.

.2 Flexmaster.

2.17 Manual Dampers

.1 Butterfly Manual Dampers:

.1 Fabricate from two gauges heavier than duct in which installed, of same material as ductwork or galvanized steel in fibreglass ductboard.

.2 Align operating handle with damper blade.

.3 Provide 50 mm standoff bracket for insulated duct systems.

.4 Damper Manufacturers:

.1 Ruskin.

.2 American Warming and Ventilating.

.5 Operator Manufacturers:

.1 Accessible Ductwork: Ventlok; Type 620 or 635.

.2 Accessible Insulated Ductwork: Ventlok; Type 639.

.3 Concealed Ductwork: Ventlok; Type 677 with extended operating rod and concealed regulator with plain cover.

.2 Manual Opposed-Blade Balancing Dampers:

.1 Externally operated gang airfoil, damper blades.

.2 Fabricate from same material as ductwork.

.3 Stainless steel or nylon sleeve bearings.

.4 Construction shall have interlocking edges and maximum 250 mm blade width.

.5 Acceptable Manufacturers:

.1 Ruskin; CD102.

.2 American Warming & Ventilating; Model VC-31.

2.18 Back Draft Dampers

.1 General:

.1 Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

.2 Heavy Duty Aluminum Counterbalanced Back Draft Dampers

.1 Fabrication:

.1 Frame: 57 mm by minimum 3.2 mm 6063-T5 extruded aluminum channel with front flange and rear flange and galvanized steel braces at mitered corners.

.2 Blades:

.1 Style: Single piece, overlap frame.

.2 Action: Parallel.

.3 Orientation: As indicted on drawings.

.4 Material: Minimum 1.8 mm 6063-T5 extruded aluminum.

.5 Width: Maximum 152 mm.

.3 Bearings: Corrosion-resistant, long-life, synthetic, formed as single piece with axles.

.4 Blade Seals: Extruded vinyl, mechanically attached to blade edge.

.5 Linkage: Minimum 13 mm aluminum tie bar with stainless steel pivot pins mounted on blades.

.6 Axles: Corrosion-resistant, long-life, synthetic, locked to blade and formed as single piece with bearings.

.7 Counterbalances: Adjustable zinc plated steel weights mechanically attached to blade enabling damper to operate over wide range of pressures.

.8 Mounting:

.1 Suitable for mounting in vertical, horizontal airflow up, and horizontal airflow down positions.

.2 Configured for positions as shown on Drawings.

.9 Finish: Mill aluminum.

.2 Performance Data:

.1 Temperature Rating: Withstand minus 40 to 93 ^{o}C.

.2 Maximum Back Pressure: 4 kPa.

.3 Maximum Air Velocity: 12.7 m/s.

.4 Operation of Blades:

.1 Start to Open: 2.5 Pa.

.2 Fully Open: 12.5 Pa.

.2 Pressure Drop: Maximum 38 Pa at 7.6 m/s through 600 mm by 600 mm damper.

.3 Accessories:

.1 Duct Transition Connection: Rectangular.

.2 Factory Sleeve: Minimum 0.95 mm thick (20-gauge) thickness, minimum 305 mm length.

.4 Manufacturer and Product: Ruskin; Model CBD6.

2.19 Fire Dampers

.1 Duct Mounted Fire Dampers in Fire Walls with Rating of 2 Hours or Less:

.1 NFPA 90A rated for 1-1/2-hour service.

.2 Blades, frame, and mounting angles same material as ductwork.

.3 Accordion style folded blades.

.4 74 °C fusible link.

.5 Approved for installation with 2-hour fire rating.

.6 Rated, manufactured, tested, and approved in accordance with UL 555.

.7 Blades out of airstream when open (Type B).

.8 Furnish with sleeved frame for duct connections.

.9 Labeled for use in dynamic mode.

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure.

.11 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0130, Type B.

.2 Ruskin; IBD20, Type B.

.2 Duct Mounted Fire Dampers in Walls with 3-Hour or Greater Fire Rating:

.1 NFPA 90A rated for 3-hour service.

.2 Blades, frame, and mounting angles.

.3 Accordion style folding blades.

.4 74 °C fusible link.

.5 Approved for installation in 4-hour wall.

.6 Rated, manufactured, tested, and approved in accordance with UL 555.

.7 Blades out of airstream when open (Type B).

.8 Furnish with sleeved frame for duct connection.

.9 Labeled for use in dynamic mode.

.10 Furnish dynamic and horizontal mounted dampers with springs for proper closure.

.11 Corrosive Service Dampers: Type 316 stainless steel.

.12 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0530, Type B.

.2 Ruskin; IBD23, Type B.

.3 Ceiling Grille and Diffuser Fire Dampers:

.1 UL Listed assembly with frame.

.2 Butterfly type blades.

.3 74 ^{o}C fusible link.

.4 Radiation type damper.

.5 Acceptable Manufacturers:

.1 Nailor-Hart; Model 0722 or 0716.

.2 Ruskin; Type CFD Series.

2.20 Control Dampers

.1 Refer to Section 15901 - HVAC Controls, Field Components and Instruments for requirements.

2.21 Sound Attenuators

.1 Packed Type (SIL):

.1 Fabricate from not less than 0.79 mm (22-gauge) sheet metal of same material as ductwork.

.2 Furnish perforated interior partitions with moisture-resistant mineral fibre carrying an NFPA 255 Flame Spread Index of no greater than 20.

.3 Pressure rated airtight at 1500 Pa.

.4 Furnish vapor barrier lining on inside face of sound trap.

.5 Size and Performance: As indicated on Duct Silencer Schedule.

.6 Manufacturers:

.1 Vibro-Acoustics.

.2 Industrial Acoustics Co.

.3 Rink.

.2 Cross-Talk Silencers (XT):

.1 Fabricate from not less than 0.79 mm thick (22-gauge) galvanized sheet metal.

.2 Acoustic media shall be inorganic, rot, odour and moisture proof, and protected by perforated metal.

.3 All inlets and outlets are to be suitably rounded.

.4 Size and performance: As indicated on Cross Talk Silencer schedule.

.5 Manufacturers:

.1 Vibro-Acoustics; XT Series

2.22 External Duct Insulation

.1 Refer to Section 15085 - Mechanical Thermal Insulation.

2.23 Miscellaneous Accessories

.1 Sheet Metal Plenums:

.1 Fabricate from minimum 1.3 mm thick (18-gauge) metal of same material as ductwork.

.2 Brace with frame of same material for rigidity.

.3 Line with sound attenuation material where indicated.

.2 Louver and Grille Blank-Off Sections:

.1 Fabricate from 20-gauge sheets of same material as louver/grille.

.2 Line with sound attenuation/insulating material.

.3 Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

.3 Auxiliary Drain Pans:

.1 Dimensions: Minimum 152 mm larger in both dimensions than equipment it is serving and 51 mm high, minimum.

.2 Construction: 16-gauge galvanized steel with brazed joints. Pans shall be watertight and have hemmed edges.

.3 Drain Connection:

.1 Minimum 25 mm IPS or as shown on Drawings.

.2 Locate at lowest point of drain pan.

.4 Prefabricated Roof Curb:

.1 Prefabricated roof curbs, flashing and counterflashing shall be constructed of minimum 2.0 mm thick aluminum. Flashing and counter flashing shall be by Others.

.2 Internal Insulation:

.1 Minimum of 38 mm thick, 48 kg/m^3 density, glass fibre insulation.

.2 Insulation seams sealed to prevent condensation.

.3 Welded or tabbed and riveted construction will be acceptable. Both types of construction shall be manufactured and sealed as required to be watertight and weatherproof.

.4 Lower section of roof curb that will be integrated with roofing system shall be constructed to accommodate roofing system provided.

.5 Top surface of curb shall have rubber weather-seal pad. Provide wooden nailer sections as required for installation.

.6 Sheet metal counterflashing shall be provided to accommodate rectangular or round ductwork.

.7 Sheet metal screws and rivets shall be stainless steel or coated with corrosion-resistant material.

.8 Height of roof curb shall be 305 mm, unless otherwise indicated herein or on Drawings.

.9 Length and width of roof curb shall be sized by Contractor for particular application.

.10 Manufacturer:

.1 Factory fabricated by equipment manufacturer.

.5 Accessories Hardware:

.1 Instrument Test Holes:

.1 Cast metal, material to suit duct material, including screw cap and gasket and flat mounting gasket.

.2 Size to allow insertion of pitot tube and other testing instruments.

.3 Provide in length to suit duct insulation thickness.

.2 Flexible Duct Clamps:

.1 Stainless steel band with cadmium-plated hex screw to tighten band with worm-gear action.

.2 Provide in sizes from 75 mm to 450 mm to suit duct size.

.3 Adhesives: High strength, quick setting, neoprene based, waterproof and resistant to gasoline, and grease.

3. EXECUTION

3.1 General Installation

.1 Miscellaneous:

.1 Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.

.2 Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.

.3 Align ductwork accurately at connections, within 3.2 mm misalignment tolerance and with internal surfaces smooth.

.4 Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

.2 Ductwork Location:

.1 Locate ductwork runs vertically and horizontally, unless otherwise indicated.

.2 Avoid diagonal runs wherever possible.

.3 As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.

.4 In general, install as close to bottom of structure as possible.

.5 For ductwork run above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.

.6 Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

.7 Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

.3 Penetrations:

.1 Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.

.2 Clearances:

.1 For uninsulated ducts, allow 25 mm clearance between duct and sleeve, except at grilles, registers, and diffusers.

.2 For insulated ducts, allow 25 mm clearance between insulation and sleeve, except at grilles, registers, and diffusers.

.3 Closure Collars:

.1 Minimum 100 mm wide on each side of walls or floors where sleeves or prepared openings are installed.

.2 Fit collars snugly around ducts and insulation.

.3 Same gauge and material as duct.

.4 Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.

.5 Use fasteners with maximum 150 mm centers on collars.

.4 Packing: Mineral fibre in spaces between sleeve or opening and duct or duct insulation.

.4 Concealment:

.1 Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.

.2 Do not encase horizontal runs in solid partitions, except as specifically shown.

.3 Limit clearance to 25 mm where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

.5 Coordination with Other Trades:

.1 Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.

.2 Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.

.3 Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.

.4 Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

.6 Shower Room and Toilet Room Exhaust Ductwork:

.1 Joints and Seams: Seal watertight.

.2 Slope branch ducts downward to grille.

.7 Fume Hood, and Laboratory Exhaust Ductwork:

.1 Seal joints and seams with chemical-resistant mastic.

.2 Rivet butt joints with minimum of eight pop rivets.

3.2 Rectangular Ductwork

.1 Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.

.2 If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

3.3 Rectangular Ductwork Fittings

.1 Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.

.2 Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.

.3 Make offsets with maximum angle of 45 degrees.

.4 Use fabricated fittings for changes in directions, changes in size and shape, and connections.

3.4 Rectangular Ductwork Transverse Joints

.1 Install each run with a minimum of joints.

.2 Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

.3 Mechanical Joint Option:

.1 Construct transverse joints with Ductmate 25/35 duct connector systems, W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system.

.2 When using W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.

.3 When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.

.4 For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.

.5 Conform to SMACNA Class A sealing requirements.

3.5 Rigid Round Ductwork

.1 Except where interrupted by fittings, install round ducts in lengths not less than 3.6 metres.

3.6 Rigid Round Ductwork Joints

.1 Rigid round ductwork joints shall be in accordance with SMACNA Round Industrial Duct Construction Standards, unless otherwise specified.

.2 Supply and Return System Joints:

.1 Less than 900 mm: Slip coupling.

.2 Larger than 900 mm: Flanged connector, Van Stone, or welded companion flange type.

.3 Exhaust and Return System Joints:

.1 All Sizes, Spiral Seam Duct: Welded flanged connector.

.2 All Sizes, Longitudinal Seam Duct: Van Stone flange connector.

3.7 Insulated Flexible Duct

.1 Installation:

.1 Where shown, between branch duct and ceiling diffusers and grilles.

.2 Without sags, kinks, sharp offsets, or elbows.

.3 As straight and taut as possible.

.2 Connection: Connect flexible ductwork to round collars, air distribution devices, and terminal units in accordance with flexible duct manufacturer's recommendations.

.3 Length:

.1 Maximum length of low-pressure flexible duct (construction pressure class up to 500 Pa) to be 2400 mm.

.2 Maximum length of medium pressure flexible duct (construction pressure class up to 1000 Pa) to be 1200 mm.

.4 Flexible ductwork shall not pass through wall, floor, or fire resistant rated assembly.

3.8 Ductwork Hangers and Supports

.1 Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

.2 Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

.3 Install additional bracing on ductwork as required, to prevent ballooning or breathing.

.4 Support horizontal ducts within 610 mm of each elbow and within 1220 mm of each branch intersection.

.5 Support vertical ducts at maximum interval of 4900 mm and at each floor.

.6 Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

.7 In new construction, install concrete insert prior to placing concrete.

3.9 Flexible Connections

.1 Flexible Collars and Connections:

.1 Use between fans and ducts.

.2 For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.

.3 For rectangular ducts, lock flexible connections to metal collars.

.4 Provide flexible connections between heat pump units and their associated supply and return ductwork

3.10 Dampers

.1 General:

.1 Inspection:

.1 Inspect areas to receive dampers.

.2 Notify Contract Administrator of conditions that would adversely affect installation or subsequent utilization of dampers.

.3 Do not proceed with installation until unsatisfactory conditions are corrected.

.2 Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.

.3 Install square and level.

.4 Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.

.5 Damper blades and hardware shall operate freely without obstruction.

.6 Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.

.7 When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.

.8 Head and sill shall have stops.

.9 Suitable for installation in mounting arrangement shown.

.10 Do not compress or stretch damper frame into duct or opening.

.2 Manual Dampers:

.1 Provide balancing dampers for grilles and diffusers in branch duct as near main as possible.

.2 Add or remove balancing dampers as requested by air balancing firm for necessary control of air.

.3 Back Draft Dampers:

.1 Install dampers square and free from racking with blades running horizontally.

.2 Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

.4 Fire Dampers:

.1 At ceiling grille and diffuser fire dampers, provide thermal blankets where required by local authorities.

.2 Install 1-1/2-hour rated, unless otherwise indicated, at locations shown and in accordance with SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.

3.11 Access Doors

.1 Ceilings:

.1 Ceiling access doors provided by Others, coordinate size and location for complete access to and removal of all internal components of heat pump units, balancing valves, shut-off valves and balancing dampers.

.2 Coordinate with Architectural reflected ceiling plans, lighting and fire protection sprinklers system.

.3 Refer to Architectural interior finishing specification sections for additional access doors requirements.

.2 Ductwork: Install access doors in ductwork, in accordance with manufacturer's instructions, at each:

.1 Duct mounted fire damper.

.2 Duct mounted smoke or ionization detector.

.3 Motorized damper.

.4 Sail switch.

.5 Turning vane.

.6 Volume damper.

.7 Automatic damper.

.8 Temperature controller.

3.12 Sound Attenuators

.1 Install where shown and in accordance with applicable SMACNA Manual and manufacturer's recommendations.

.2 Provide dielectric separation where attenuator material differs from connected duct system.

3.13 External Duct Insulation

.1 Refer to Section 15085 - Mechanical Thermal Insulation.

3.14 Miscellaneous Accessories

.1 Auxiliary Drain Pans:

.1 Route drain lines to nearest floor or hub drain independent of any other drain.

.2 Slope drain pans toward drain connection to promote drainage.

.2 Louver and Grille Blank-off Sections:

.1 Attach airtight to louver or grille and install to allow for easy removal.

.3 Prefabricated Roof Curb:

.1 Provide for ductwork roof penetrations.

.2 Roof curb installation, including flashing and counterflashing, shall provide watertight weatherproof enclosure. Coordinate with Others.

.3 Attach counterflashing to ductwork via rubber gasketed sheet metal screws.

.4 Fill space between counterflashing and ductwork with silicon-based sealant. Sealant shall also be applied at all sheet metal screw locations.

.4 Inspection Plates and Test Holes:

.1 Where required in ductwork for balance measurements.

.2 Test holes shall be, airtight and noncorrosive with screw cap and gasket.

.3 Extend cap through insulation.

3.15 Duct Sealing

.1 Seal duct seams and joints as follows:

.1 In accordance with SMACNA requirements.

.2 In addition to other requirements, provide the following duct sealing:

.1 For interior ductwork, tape joints with Hardcast Lag-Rite tape and bonder or Ray-Chem shrink tape.

.2 For exterior ductwork, tape joints with Hardcast outdoor tape and rosin.

.2 If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

.3 Seal externally insulated ducts prior to insulation installation.

.4 Provide additional duct sealing as required to comply with Article - Ductwork Leakage Testing.

3.16 Balancing and Testing of Air Systems

.1 Perform testing in accordance with the requirements of Section 15950 - HVAC Systems Testing, Adjusting, and Balancing.

3.17 Cleaning

.1 Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

.2 Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

3.18 Supplements

.1 The supplements listed below, following End of Section, are a part of this Specification:

.1 15810-01 Ductwork Schedule.

.2 15810-02 Cross Talk Silencers Schedule.

.3 15810-03 Duct Silencer Schedule

END OF SECTION

DUCTWORK SCHEDULE
15810-01

AREA SERVED	SYSTEMS	SERVICE	SECTION	SMACNA DUCT CONSTRUCTION CRITERIA			APPLICABLE REMARKS
				PRESSURE CLASS (Pa)	MATERIALS OF CONSTRUCTION	SEAL CLASS	
FILTER AREA	MAU-H001	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H002, EF-H003	TRANSFER	ALL	750	ALUMINUM	C	
	EF-H004	EXHAUST AIR	ALL	-500	ALUMINUM	C	
DISINFECTION AREA	EF-H005	EXHAUST AIR	ALL	-500	FIBREGLASS REINFORCED PLASTIC (FRP)	C	A
OZONE MIXING CHAMBER	EF-H006	EXHAUST AIR	ALL	-500	ALUMINUM	C	
PILOT PLANT	MAU-H011	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H013	EXHAUST AIR	ALL	-500	ALUMINUM	C	
RESIDUALS HANDLING AREA	MAU-H012	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H014	EXHAUST AIR	ALL	-500	ALUMINUM	C	
OZONE GENERATOR ROOM	MAU-H021, HRU-H022	SUPPLY AIR	ALL	750	STAINLESS STEEL	C	
	HRU-H022, EF-H023	EXHAUST AIR	ALL	-500	STAINLESS STEEL	C	
ACCESS CORRIDORS 2,3,5,6	EF-H024, EF-H025	SUPPLY AIR	ALL	750	ALUMINUM	C	
		EXHAUST AIR	ALL	-500	ALUMINUM	C	
BLOWER ROOM (VENTILATION DUCTS)	EF-H002	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H040	EXHAUST AIR	ALL	-500	ALUMINUM	C	
POLYMER FACILITY	MAU-H031	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H037	EXHAUST AIR	ALL	-500	ALUMINUM	C	
CHEMICAL STORAGE AND FEED	MAU-H032, MAU-H033	SUPPLY AIR	ALL	750	FIBREGLASS REINFORCED PLASTIC (FRP)	C	A
	EF-H038, EF-H039	EXHAUST AIR	ALL	-500	FIBREGLASS REINFORCED PLASTIC (FRP)	C	A
MAINTENANCE WORKSHOP SYSTEM	HRU-H034	SUPPLY AIR	ALL	750	ALUMINUM	C	
	HRU-H034, EF-H044	EXHAUST AIR	ALL	-500	ALUMINUM	C	
DAF GALLERIES	MAU-H051	SUPPLY AIR	ALL	750	ALUMINUM	C	
	EF-H053	TRANSFER	ALL	750	ALUMINUM	C	
	EF-H052	EXHAUST AIR	ALL	-500	ALUMINUM	C	
ELECTRICAL ROOMS	AHU-H035, AHU-H062	SUPPLY AIR	ALL	750	ALUMINUM	C	
		RETURN AIR	ALL	-500	ALUMINUM	C	
RAW WATER PUMP ROOM	AHU-H061	SUPPLY AIR	ALL	750	ALUMINUM	C	
		RETURN AIR	ALL	-500	ALUMINUM	C	
MECHANICAL ROOMS AND FIRE PUMP ROOM	EF-H041, EF-H051, EF-H063, EF-H065	SUPPLY AIR	ALL	750	ALUMINUM	C	
		EXHAUST AIR	ALL	-500	ALUMINUM	C	
ADMINISTRATION AREA VENTILATION AIR	AHU-H071	SUPPLY AIR	ALL	750	GALVANIZED STEEL	C	B
	EF-H-75, EF-H076	RETURN AIR	ALL	-500	GALVANIZED STEEL	C	
	EF-H066, EF-H067	EXHAUST AIR	ALL	-500	GALVANIZED STEEL	C	
WATER SOURCE HEAT PUMP SYSTEMS	HP-H045,46, 70,77-99	SUPPLY AIR	ALL	750	GALVANIZED STEEL	C	B
		RETURN AIR	ALL	-500	GALVANIZED STEEL	C	B
WASHROOMS, LOCKER ROOM AND FUME HOOD EXHAUST	EF-H043, EF-H072, EF-H073	EXHAUST AIR	ALL	-500	ALUMINUM	C	

REMARKS:

A: REFER SECTION 15815, FIBREGLASS REINFORCED PLASTIC DUCTWORK AND ACCESSORIES

B: DUCTWORK COMPLETE WITH INSULATION LINER

CROSS TALK SILENCER (XT) SCHEDULE 15810-02

EQUIPMENT TAGS	AIRLFOW CAPACITY	Maximum Allowable Pressure Drop	LOCATION	DIMENSIONS			REMARKS
				WIDTH	HEIGHT	LENGTH	
	L/s	[Pa]		[mm]	[mm]	[mm]	
XT-H071	198	12.5	WALL	300	300	750	
XT-H072	132	12.5	WALL	300	200	750	
XT-H073	377	12.5	WALL	400	400	750	
XT-H074	330	12.5	WALL	400	350	750	
XT-H075	87	12.5	WALL	200	200	750	
XT-H076	87	12.5	WALL	200	200	750	
XT-H077	87	12.5	WALL	200	200	750	
XT-H078	87	12.5	WALL	200	200	750	
XT-H079	87	12.5	WALL	200	200	750	
XT-H080	87	12.5	WALL	200	200	750	
XT-H081	87	12.5	WALL	200	200	750	
XT-H082	198	12.5	WALL	300	300	750	
XT-H083	132	12.5	WALL	300	200	750	
XT-H084	132	12.5	WALL	300	200	750	
XT-H085	132	12.5	WALL	300	200	750	
XT-H086	198	12.5	WALL	300	300	750	
XT-H087	87	12.5	WALL	200	200	750	
XT-H088	87	12.5	WALL	200	200	750	
XT-H089	87	12.5	WALL	200	200	750	

DUCT SILENCER SCHEDULE
15810-03

SYMBOL			SIL-H071	SIL-H075	SIL-H076
SERVING			AHU-H071 SUPPLY DUCT	EF-H075, EXHAUST DUCT	EF-H076, EXHAUST DUCT
AIRFLOW DATA	CAPACITY	L/s	1522	1050	472
	FACE VELOCITY	m/s	6	-5	-4
	FLOW DIRECTION	FWD/REV	FWD	REV	REV
	PRESSURE DROP	Pa	52	32	23
SIZE	WIDTH	mm	500	450	350
	HEIGHT	mm	500	450	350
	LENGTH	mm	2134	1829	1524
DYNAMIC INSERTION LOSS (dB)	MID OCTAVE BAND FREQUENCY (Hz)	63	11	6	6
		125	18	10	12
		250	34	23	21
		500	38	40	26
		1K	48	40	28
		2K	34	31	20
		4K	22	20	15
		8K	18	13	13
MANUFACTURER			Vibro-Acoustic	Vibro-Acoustic	Vibro-Acoustic
MODEL NO.			EXRMB-LV-FA	RMB-HV-F7	RMB-MHV-F2
APPLICABLE REMARKS			A		

REMARKS

A: Extended width silencer

FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK AND ACCESSORIES

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 AMCA: 500-D, Laboratory Methods of Testing Dampers for Rating.

.2 ANSI:

.1 B16.1, Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.

.2 B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24.

.3 B18.22.1, Plain Washers.

.3 ASTM:

.1 A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

.2 A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.

.3 C582, Standard Specification for Contact-Molded RTP Laminates for Corrosion Resistant Equipment.

.4 D2563, Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.

.5 D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

.6 D3982, Standard Specification for Contact Molded “Fiberglass” (Glass Fiber Reinforced Thermosetting Resin) Duct and Hoods.

.7 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.4 Factory Mutual (FM) 4922 approval for non-sprinklered smoke removal installation.

.5 Canadian Government Specification Board Standard:

.1 CAN/CGSB-41.22-93 Fibreglass Reinforced Plastic Corrosion Resistant Equipment.

1.2 Submittals

.1 Shop Drawings:

.1 Duct:

.1 Statement of resins and reinforcing proposed for use.

.2 Pressure, vacuum, and temperature rating of duct.

.3 Dimensions of subassemblies to be shipped.

.4 Manufacturer's data and descriptive literature for duct accessories.

.5 Drawings showing layout, support, and joint details.

.6 Stamped and signed structural engineering design calculations.

.7 Information, details, and requirements for installation and support of duct and torque values for flange bolting.

.8 Name of manufacturer.

.2 Supports:

.1 Location plan.

.2 Type and details.

.3 Materials of construction.

.4 Stamped and signed structural engineering design calculations for special supports.

.3 Expansion Joints/Flexible Connectors:

.1 Type and model.

.2 Materials of construction.

.3 Force required for expansion/contraction.

.4 Name of manufacturer.

.4 Butterfly Dampers:

.1 Statement of resins and reinforcing proposed for use.

.2 Pressure, vacuum, and temperature rating.

.3 Materials of construction.

.4 Total weight including operator.

.5 Drawings showing overall dimensions and connection size.

.6 Type and model.

.7 Name of manufacturer.

.2 Information Submittals:

.1 Qualifications:

.1 Fabricator: List of references substantiating experience.

.2 Contractor: Manufacturer's certification that Contractor is qualified for installation work.

.2 Manufacturer's installation instructions.

.3 Certificates:

.1 Certificate of Satisfactory Installation in accordance with Section 01650, Equipment Installation.

.4 Manufacturer's factory inspection report.

.5 Damper and Blast Gate: AMCA 500-D leakage test results by AMCA-approved laboratory.

1.3 Quality Assurance

.1 Subcontractor Qualifications: Minimum 5 years' experience.

.2 Contractor Qualifications: Minimum 5 years' experience.

1.4 Delivery, Storage, and Handling

.1 Do not ship ducting by nesting small diameter components inside larger diameter components.

.2 Protect flanged sections by bolting to wooden blinds 50 mm greater than outside diameter of flange.

.3 For nonflanged components, use either rigid plugs inside ends to prevent deflection or protect with wooden boxes.

.4 Crate materials whenever practical prior to shipment.

.5 Firmly fasten and pad components shipped to prevent shifting or flexing of components while in transit.

1.5 Environmental Requirements

.1 Temperature: Make field joints only when ambient temperature is above 13 ^{o}C and below 37 ^{o}C.

2. PRODUCTS

2.1 Materials

.1 Resin:

.1 Resin System: Premium corrosion-resistant, fire-retardant vinylester, or other qualified thermosetting resin. Resin to be selected by fabricator, subject to approval of Contract Administrator, and suitable for intended service with no fillers or thixotropic agents.

.2 Liner Resin: Premium grade and corrosion resistant.

.3 Structural wall resin may be of different chemical resistance, subject to conditions of service and approval of Contract Administrator.

.4 Flame Spread Index: ASTM E84, less than 25; fire retardant additives used only in structural layer.

.5 Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.

.6 Add ultraviolet absorbers to surfacing resin to improve weather resistance.

.7 Color: Use no dyes, pigments, or colorants, except in exterior gel coat. Paint the duct with epoxy or urethane paint.

.8 For interior duct, final coat shall be factory applied intumescent coating to achieve designated results for low smoke development.

.2 Reinforcement:

.1 Veil: Chemical surfacing mat, polyester fabric, 0.31 mm to 0.41 mm thick, with finish and binder compatible with lay-up resin.

.2 Corrosion Barrier: Resin-rich interior surface of nominal 2.5 to 0.3 mm thick (100 to 120 mils), using chopped strand mat backing the veil. Use no additive in corrosion barrier.

.3 Chopped Strand Mat: Type E glass, minimum 0.45 kg per square metre, with silane finish and styrene soluble binder.

.4 Continuous Roving for Chopper Gun Spray-Up: Type E glass.

.5 Woven Roving: Type E glass, nominal 0.8 kg per square metre, 4 by 5 weave, with silane type finish.

.6 Continuous Roving for Filament Winding: Type E glass with silane type finish.

.3 Fasteners:

.1 Bolts: ASTM A193/A193M, Type 316 stainless steel, ASA coarse thread series, Grade B 8M hex head.

.2 Nuts: ASTM A194/A194M, Type 316 stainless steel, Grade 8M.

.3 Washers: ANSI B18.22.1, flat, Type 316 stainless steel.

2.2 Ductwork

.1 Design Requirements:

.1 Conform to ASTM D3982

.2 Duct manufacturer's design for round section, including duct wall thickness and stiffeners.

.3 Take into account expansion from seasonal temperature variations.

.2 Service Conditions:

.1 System Maximum Pressure: 500 Pa.

.2 System Maximum Vacuum: 500 Pa.

.3 Location: Inside.

.4 Ambient Temperature: 0 to 40 ^{o}C.

2.3 Fabrication

.1 Physical Properties: Meet or exceed requirements of ASTM D3982

.2 Squareness of ends, fittings, elbows, and butt joints shall meet or exceed requirements of ASTM D3982

.3 Keep use of flanges to a minimum; butt joints are preferred method of joining sections of duct, unless otherwise indicated on drawings.

FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK AND ACCESSORIES

.4 Butt joints shall only be permitted in duct sections that are accessible for inside overlay. Internal overlay to consist of two layers of 0.45 kg per square metre of fiberglass mat followed by one layer of surfacing veil, as a minimum.

.5 Flanges for Duct to Duct Connections and Duct Wall Thicknesses: ASTM D3982 rated for specified pressure and vacuum.

.6 Flange dimensions (except thickness) and drilling patterns for flanges that connect to equipment, valves, or dampers are to correspond to ANSI B16.5, Class 150 or ANSI B16.1, Class 125.

.7 Furnish gussets on flanged nozzles from ducts.

.8 Back Face of Flanges: Spot-faced, flat and parallel to flange face, and of sufficient diameter to accept ANSI metal washer under bolt head or nut.

.9 Laminate:

.1 Reinforce inner surface of ducts with resin-rich surfacing veil 0.25 mm to 0.51 mm thick.

.2 Construct interior layer of resin reinforced with at least 2 plies of chopped strand mat; thickness at least 2.5 mm.

.3 Glass content of combined inner surface and interior layer shall be 27 percent plus or minus 5 percent.

.10 Duct and Fittings:

.1 Type: Contact molded or filament wound, meeting requirements of ASTM D3982.

.2 Joints: Butt wrapped except flanged at connections to expansion joints, butterfly valves, blast gates, or mechanical equipment and unless otherwise indicated on drawings.

.3 Fittings: Plain end or flanged, manufacturer’s standard sizes. Comply with NBS PS-15 with a chemical resistance equal to or greater than the duct.

.4 Gaskets: EPDM, 5 mm thick, full-face, Type A Durometer of 50-60.

.11 Manufacturers:

.1 Composites.

.2 Augusta Fiberglass.

.3 Industrial Plastics Fabricator.

.4 Precisioneering Ltd.

FIBREGLASS REINFORCED PLASTIC (FRP) DUCTWORK AND ACCESSORIES

.12 Supports:

.1 Supports for FRP ductwork shall be provided per Contractor-Designed.

.2 Maximum Duct Deflection: 12 mm, including special sections at road crossings.

.3 Support Spacing:

.1 600 mm Diameter and Larger: 6 m, maximum.

.2 500 mm Diameter and Smaller: 4.6 m, maximum.

.13 Marking:

.1 Identify each duct component with fabricator's name, resin, minimum thickness, and date of manufacture.

.2 Use permanent marking. Seal decals and labels into laminate exterior with resin.

.3 For piece marking used for installation, use oil-based paint for easy removal.

.14 Cure products to at least 90 percent of minimum Barcol hardness specified by resin manufacturer.

.15 Expansion Joints/Flexible Connections:

.1 Provide where indicated on Drawings or as required for proper duct installation. Expansion joints and flexible connections shall be flanged type unless specifically indicated to be plain end (slip-on) type on drawings.

.2 Flanged Type Expansion Joints shall be W-design configuration, constructed with compound curve molded corners with arch premolded corners on rectangular expansion joints shall be completely molded and free of splices. (Type): W-design configuration with integral flanges suitable for service with FRP duct.

.3 Material: Fabric-reinforced Hypalon resistant to UV light.

.4 Backing Rings: 10 mm thick, 50 mm wide, Type 316 stainless steel. ANSI B16.1, Class 25 diameter and drilling.

.5 Length: 150 mm (size 550 mm dia. and smaller), flange-to-flange.

.6 Extension: 12 mm.

.7 Compression: 50 mm.

.8 Lateral Offset: 25 mm.

.9 Thickness: 6.4 mm, minimum.

.10 Manufacturer and Product: RM-Holz; Style 945.

.11 Slip-on type expansion joints and flexible connections shall be sized to fit tightly on the outside diameter of the duct, secured in place by stainless steel worm screw type adjustable clamps to provide gas-tight connections.

.16 Butterfly Dampers:

.1 Dampers:

.1 Single-blade type, complete with channel-type frame, close-fitting axle, and bearings.

.2 Same inside diameter as connecting ductwork.

.3 Axles not less than 20 mm in diameter and shall be continuous through damper.

.4 When used for balancing only, shall be furnished with full circumference molded in blade stop.

.2 Design Requirements:

.1 Each damper shall be designed for the following conditions:

.1 Air Temperature Range: 0 to 40 ^{o}C.

.2 Differential Pressure: 500 Pa.

.3 Materials:

.1 FRP materials for dampers shall be same resin as used in ductwork.

.2 Requirements for flame spread and smoke development shall be same as required for ductwork.

.4 Construction:

.1 Frames: Fiberglass reinforced plastic with resin as described herein.

.2 Blades: Fiberglass reinforced plastic with resin as described herein. Blade thickness and stiffeners as required to meet design conditions. 0.9 m and under: 6.3 mm thick. Above 0.9 m: 12.7 mm thick.

.3 Axles: Continuous FRP rod with resin as described herein. Axle to extend 150 mm beyond frame.

.4 Bearings: Molded PTFE.

.5 Blade Stops: FRP with resin as described herein.

.6 Blade Seals: Neoprene.

.7 Shaft Seals: Neoprene.

.8 Flanges: To match ductwork flanges.

2.4 Source Quality Control

.1 Factory Inspection: Inspect fabrications for required construction, intended function and conformance with referenced standards.

.2 Inspection of products is required prior to shipment, unless specifically waived in writing by Contract Administrator.

.3 Notify Contract Administrator one week prior to the estimated date of inspection.

.4 Repairs authorized by Contract Administrator shall be reinspected before final acceptance, unless specifically waived.

3. EXECUTION

3.1 General

.1 Refer to Ductwork Schedule in Section 15810-01 for extent of FRP ductwork.

3.2 Preparation

.1 Verify dimensions and conditions in field.

.2 Layout routing in straight lines parallel to building lines.

.3 Coordinate support locations with layout and joints.

3.3 Installation

.1 Ductwork:

.1 Cut, fit, and install in accordance with duct manufacturer’s recommendations.

.2 Seal cut edges with compatible resin.

.3 Ductwork shall be free of vibration when in operation. Vibration isolation devices shall be provided and installed by Contractor.

.4 Install plumb and straight and in proper alignment.

.5 Provide for expansion and contraction of ductwork and fittings.

.6 Anti-seize thread compound shall be applied to all nuts and bolts.

.7 Flange bolts shall be tightened to torque values specified by manufacturer. Install flat washer under each nut and bolt head.

.2 Field Joints:

.1 Provide material in kit form; one kit for one joint.

.2 Make joints only when ambient temperature is above 13 ^{o}C and below 37 ^{o}C.

.3 Made by manufacturer certified Subcontractor.

.3 Dampers: Unless otherwise necessary for proper operation of damper, axles shall be installed in horizontal position.

3.4 Field Testing

.1 Field test ductwork after installation and before concealment or burying, with air test to 150 percent of maximum working pressure for a period of 4 hours. Leaks shall be corrected and duct retested until no further leaks appear.

3.5 Manufacturer's Services

.1 Manufacturer's Representative: Present at Site or classroom designated by Contract Administrator for minimum person-days listed below, travel time excluded:

.1 One person-day for installation assistance and inspection.

.2 One person-day for functional and performance testing and completion of Certificate of Satisfactory Installation, Form 102 as per Section 01650 - Equipment Installation.

.2 Written certification shall be submitted by duct manufacturer, indicating individuals employed by the Contractor have satisfactorily completed all training and instruction.

3.6 Adjusting

.1 After duct leakage testing, provide complete air balancing of entire system as described in Section 15950 - HVAC Systems Testing, Adjusting and Balancing.

3.7 Cleaning

.1 Blow ductwork clean using system fans; purged continuously for not less than 48 hours at a flow rate not less than design flow rate. If required, system fan shall be throttled on inlet side to prevent motor overload. Temporary screen shall be installed on system fan inlet to protect fan from entering debris.

.2 Dampers shall be smooth, clean, and free of dirt when installed.

END OF SECTION

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this Section:

.1 ARI.

.2 AMCA:

.1 99, Standards Handbook.

.2 201, Fans and Systems.

.3 203, Field Performance Measurement of Fan Systems.

.4 210, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.5 300, Reverberant Room Method for Sound Testing of Fans.

.6 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.3 ABMA: 9, Load Ratings and Fatigue Life for Ball Bearings.

.4 ANSI: S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.

.5 ASHRAE: HVAC Applications Manual.

.6 ASTM:

.1 B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

.2 D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.

.3 D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

.4 D3363, Standard Test Method for Film Hardness by Pencil Test.

.5 D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.

.6 E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

.7 NEMA: MG 1, Motors and Generators.

.8 NFPA: 45, Fire Protection for Laboratories Using Chemicals.

.9 OSHA.

.10 SSPC:

.1 SP 3, Power Tool Cleaning.

.2 SP 5, Joint Surface Preparation Standard White Metal Blast Cleaning.

.3 SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.

.4 SP 10, Joint Surface Preparation Standard Near-White Blast Cleaning.

.11 UL/ULC: 507, Electric Fans.

1.2 Definitions

.1 The following is a list of abbreviations which may be used in this Section:

.1 CISD: Chemical Industry, Severe-Duty.

.2 DWDI: Double Width, Double Inlet.

.3 FRP: Fibreglass Reinforced Plastic.

.4 SWSI: Single Width, Single Inlet.

1.3 Submittals

.1 Action Submittals:

.1 Provide for all products specified, as follows:

.1 Identification as referenced in Contract Documents.

.2 Manufacturer's name and model number.

.3 Descriptive specifications, literature and drawings.

.4 Dimensions and weights.

.5 Fan sound power level data (reference 10 to power minus 12 Watts) at design operating point.

.6 Fan Curves:

.1 Performance Curves Indicating:

.1 Relationship of flow rate to static pressure for various fan speeds.

.2 Brake horsepower curves.

.3 Acceptable selection range (surge curves, maximum revolutions per minute, etc).

.4 Static pressure, capacity, horsepower demand and overall efficiency required at the duty point, including drive losses.

.2 For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure and brake horsepower.

.7 Capacities and ratings.

.8 Construction materials.

.9 Fan type, size, class, drive arrangement, discharge, rotation and bearings.

.10 Wheel type, diameter, revolutions per minute, and tip speed.

.11 Motor data.

.12 Power and control wiring diagrams, including terminals and numbers.

.13 Vibration isolation.

.14 Factory finish system.

.15 Color selection charts where applicable.

.16 Corrosion protection coating product data.

.17 Fibreglass Material: Statement of resins and reinforcing proposed for use.

.2 "Or Equal" Equipment:

.1 Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.

.2 Where submitted equipment results in change to ductwork and equipment configuration shown on drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

.2 Informational Submittals:

.1 Recommended procedures for protection and handling of products prior to installation.

.2 Manufacturer's installation instructions.

.3 Certificate of Equipment Delivery, Satisfactory Installation, Satisfactory Performance in accordance with Section 01650, Equipment Installation.

.4 Test reports.

.5 Operation and maintenance data in conformance with Section 01730, Operation and Maintenance Manuals. Include as-built version of equipment schedules.

1.4 Quality Assurance

.1 Performance Ratings: Tested in accordance with AMCA 210.

.2 Sound Ratings: Tested in accordance with AMCA 300.

.3 Fabrication: In accordance with AMCA 99.

1.5 Extra Materials

.1 Furnish, tag, and box for shipment and storage the following spare parts, and materials:

Item	Quantity
Vee Belts	One complete set per belt driven unit

.2 Delivery: In accordance with Section 01600, Material and Equipment.

2. PRODUCTS

2.1 Equipment Schedules

.1 Some specific equipment requirements are listed in Equipment Schedules. Refer to Supplements.

2.2 Nameplates

.1 All units shall include factory installed permanently attached nameplate displaying unit model and serial number.

2.3 Operating Limits

.1 Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408-69.

2.4 Acoustical Levels

.1 Equipment selections shall produce sound power levels in each octave band no greater than those generated by base-case equipment listed in the Equipment Schedule.

.2 In no case shall the sound power level be greater than 80 dBA at a distance of 1.5 m from the equipment.

2.5 Drives

.1 Furnish multiple drive belts where motor horsepower is 1.5 kW or larger.

.2 Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.

.3 Sheaves shall be capable of providing 150 percent of motor horsepower.

.4 Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.

.5 Furnish motors for V-belt drives with adjustable rails or bases.

.6 Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.

.7 Motors 15 kW or Smaller:

.1 Variable pitch V-belt sheaves allowing at least 20 percent speed variation.

.2 Final operating point shall be at approximate sheave midpoint.

.8 Motors Larger than 15 kW: Fixed-pitch sheaves.

.9 Drive Adjustment:

.1 When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.

.2 Provide trial and final sheaves, as well as drive belts, as required.

.10 Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.

.11 Belt and Shaft Guards:

.1 Easily removable and to enclose entire drive assembly, meeting federal, OSHA and Province of Manitoba requirements.

.2 Guard faces of expanded metal having minimum 60 percent free area for ventilation.

.3 Bright yellow finish.

.12 Provide speed test openings at shaft locations.

2.6 Finishes

.1 Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.

.1 Parts cleaned and chemically pretreated with a phosphatizing process.

.2 Alkyd enamel primer.

.3 Air-dry enamel topcoat.

.2 Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.

.3 Stainless Steel Parts: Finished smooth and left unpainted.

.4 Fibreglass Parts: Finished in accordance with Paragraph, Fibreglass Material.

2.7 Cabinet Ceiling Fan

.1 General:

.1 Factory-assembled, ceiling, wall or inline mounted, centrifugal cabinet fan; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Material: Minimum 0.95 mm thick (20-gauge) galvanized steel.

.2 Construction:

.1 Minimum 2.0 mm thick (14-gauge) blower and motor support frame.

.2 Lined with minimum 12 mm acoustical insulation.

.3 Outlet duct collar with integral reinforced aluminum backdraft damper, with nylon bushings.

.4 Motor mounted on resilient vibration isolators.

.5 Motor and blower removable from unit without cabinet disassembly.

.6 Removable cabinet access panels.

.7 Air Inlet: Field convertible for bottom or end air inlet configuration.

.8 Predrilled universal mounting brackets, adjustable.

.3 Wheel: Centrifugal forward curved type, galvanized steel or plastic construction.

.4 Shaft, Bearings, Drive:

.1 Shafts: Turned, ground and polished carbon steel.

.2 Bearings: Grease lubricated, precision antifriction ball, sealed type.

.3 Drives:

.1 In accordance with Article, Drives.

.2 Factory set to the specified fan revolutions per minute.

.3 Type: Direct.

.5 Electrical:

.1 Integral wiring box.

.2 Factory-installed disconnect switch.

.6 Accessories: Provide as follows:

.1 Ceiling Grille: Factory fabricated, aluminum construction, white baked enamel finish.

.2 Speed Controller:

.1 Mounted and wired internally.

.2 Solid state electronics.

.3 Dial type combination ON/OFF switch and SPEED selector.

.4 Time delay switch, 1 to 60 minute asjustment.

.5 Isolation kit.

.6 Motor with thermal overload.

.7 UL/ULC-507 “Electric Fan”.

.7 Acceptable Manufacturers:

.1 Greenheck; SP Series

.2 Loren Cook; Gemini Series.

.3 Penn.

2.8 Inline Fan, Centrifugal, Square

.1 General:

.1 Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Construction: All aluminum.

.2 Integral duct collars.

.3 Removable side panels, for ease of service.

.4 Field convertible for side air discharge configuration.

.5 Predrilled universal mounting brackets for vertical or horizontal installation.

.6 Inlets: Aerodynamic aluminum venturi.

.7 Corrosion-resistant fasteners.

.8 Drive belt and bearings separated from air steam by enclosure.

.3 Wheel:

.1 Centrifugal backward inclined, 100 percent aluminum construction.

.2 Precision machined cast aluminum hub.

.3 Die-formed airfoil or backward inclined blades.

.4 Matched to inlet venturi.

.5 Attached to fan shaft with split taper lock bushing.

.4 Shaft, Bearings, Drive:

.1 Shafts:

.1 Turned, ground and polished carbon steel.

.2 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricable or sealed type.

.2 Selected for average life (ABMA 9 L10) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Motors and Drives:

.1 In accordance with Article, Drives.

.2 Motor enclosure shall be TEFC.

.3 Arrangement: Arrangement 9 for belt-driven.

.4 Belts: Oil and heat resistant, non-static type.

.5 Accessories: Provide as follows:

.1 Belt Guard: Sheet metal construction, OSHA type.

.2 Aluminum inlet safety screen where inlet side is not ducted.

.3 Motor and Drive Cover:

.1 Factory fabricated, OSHA type.

.2 Sheet metal construction, same material as fan housing.

.3 Vented, openings sufficient size for proper motor cooling.

.4 Insulated Housing: Fibreglass insulation, 25 mm-thick, neoprene coated, on interior of housing.

.5 Disconnect: Factory installed, nonfused, NEMA 4.

.6 Single Side Discharge (where shown on drawing): Package consisting of side duct connection collar and rear-discharge blank-off panel.

.7 Bearing Lubrication Lines:

.1 Extended to outside of fan housing.

.2 Terminate with zerk fittings.

.8 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Acceptable Manufacturers:

.1 Greenheck; Model BSQ-HP (Belt); SQ (Direct).

.2 Loren Cook; Model SQNB (Belt); SQND (Direct).

.3 Penn.

2.9 Fibreglass Fans (FRP Inline and FRP Upblast)

.1 General:

.1 Factory-assembled tubular centrifugal fan, fibreglass construction, belt drive; including housing, fan wheel, drive assembly, motor and accessories.

.2 Fibreglass Construction: In accordance with ASTM D4167.

.3 Fan Performance: AMCA 99-2408 Class I.

.4 Air Stream Hardware: Type 316 stainless steel.

.2 Fibreglass Material:

.1 Construction: Resin reinforced fibre cloth and mat.

.2 Resin:

.1 Polyester thermosetting resin.

.2 Selected by fabricator, subject to approval by Contract Administrator.

.3 Suitable for intended service with no fillers or thixotropic agents.

.4 Premium grade and corrosion resistant.

.5 Structural wall resin may be of different chemical resistance, subject to conditions of service and approval by Contract Administrator.

.6 Flame Spread Index**:**

.1 ASTM E84, less than 25; fire retardant additives used only in structural layer.

.2 Structural wall resin shall contain a minimum of 3 percent antimony trioxide to achieve required flame spread index.

.7 For outdoor locations, add ultraviolet absorbers to surfacing resin to improve weather resistance.

.8 For interior locations, final coat shall be factory applied intumescent coating to achieve designated results for low smoke development.

.9 Colour:

.1 Use no dyes, pigments, or colorants, except in exterior gel coat.

.2 Exterior gel coat shall be white.

.3 Reinforcement:

.1 Veil: Chemical surfacing mat, Nexus Surface Veil.

.2 Chopped Strand Mat: Type E glass, minimum 4.5 kg per cubic metre, with silane finish and styrene soluble binder.

.3 Continuous Roving for Chopper Gun Spray-Up: Type E glass.

.4 Woven Roving: Type E glass, nominal 0.89 kg per cubic metre, 4 by 5 weave, with silane type finish.

.4 Laminate:

.1 Inner Surface (Veil):

.1 Resin rich, veil reinforced, 0.25 to 0.5 mm thick (10 to 20-mils).

.2 Use no additives.

.3 Finish and binder compatible with lay-up resin.

.4 Reinforcement Content: Not more than 20 percent.

.2 Interior (Corrosion) Layer:

.1 Resin rich, at least two plies of chopped strand mat, nominal 100-mils to 120-mils thick.

.2 Use no additives.

.3 Construct interior layer of resin reinforced with at least two plies of chopped strand mat backing the veil.

.4 Reinforcement Content: 25 plus or minus 5 percent.

.3 Exterior (Structural) Layer:

.1 Resin with mat, cloth, woven roving or chopped strand glass reinforcement.

.2 Enough resin present to prevent surface fibre show.

.3 Exterior surface relatively smooth, with no exposed fibres or sharp projections.

.4 Wall Thickness: As required for equipment structural integrity, but not less than 4.8 mm.

.3 FRP Inline Fans

.1 Housing:

.1 Material: Fibreglass construction.

.2 Construction:

.1 Tubular housing shell

.2 Integral predrilled duct connection flanges to ensure housing concentricity and housing strength.

.3 Air straightening vanes, fibreglass construction, at fan outlet, interconnected with inner and outer shell.

.4 Bearing Base and Drive Enclosure:

.1 Bearings and belts enclosed in air insulated fibreglass housing for protection from air stream gases, fumes, and vapors.

.2 Supported by tapered gussets interlocked into outer housing.

.3 Constructed of laminated glass and resin.

.4 Bearing housing furnished with a bolted, removable Teflon shaft closure plate to facilitate bearing access.

.5 Viton shaft seal.

.5 Lifting lugs, steel, bolted to fan housing flanges.

.6 Mounting brackets, steel, bolted to fan housing flanges, as required for indicated fan arrangement.

.3 Inlet:

.1 Bolted, removable.

.2 Streamlined, bell mouth type

.3 Fibreglass construction.

.4 Matched to fan wheel inlet shroud.

.4 Bearing Lubrication Lines:

.1 Extended to outside of fan housing.

.2 Type 316 stainless steel construction.

.3 Terminated with zerk fittings.

.5 Motor Base Plate:

.1 Minimum 4.8 mm steel plate.

.2 Bolted between gussets integral to fan housing flanges.

.3 Provision for belt tensioning and adjustment.

.2 Wheel:

.1 Material: Fibreglass construction.

.2 Centrifugal, one-piece, nonoverloading, backwardly inclined blades for Tubular Inline type

.3 Mechanically fastened to end of fan shaft by Type 316 stainless steel bolt.

.3 Shaft, Bearings, Drive:

.1 Shafts:

.1 Turned, ground and polished Type 316 stainless steel.

.2 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction, ball self-aligning type.

.2 Mounted in cast iron pillow block housing.

.3 Selected for average life (ABMA 9 L_{10}) of not less than 200,000 hours operation at maximum cataloged operating speed.

.4 Suitable for fan operation in vertical configuration.

.3 Motors and Drives:

.1 Motor enclosure shall be TEFC

.2 Arrangement: Arrangement 9.

.3 Belts: Oil and heat resistant, nonstatic type.

.4 Accessories: Provide as follows:

.1 Housing Access Doors: Fibreglass construction, bolted and gasketed.

.2 Disconnect: Factory installed, nonfused, NEMA 4.

.3 Motor and Drive Cover:

.1 Factory fabricated, OSHA type.

.2 Fibreglass construction, same material as fan housing.

.3 Vented, openings sufficient size for proper motor cooling.

.4 Belt Guard: Sheet metal construction, OSHA type.

.5 Inlet Vanes: Variable position, for manual or automatic operation.

.6 Housing Access Doors: Bolted and gasketed.

.7 Shaft Seal: Lubricated.

.8 Nameplates: Type 316 stainless steel manufacturer's nameplates.

.9 Support Base: Welded metal, for standard platform or floor mounting.

.10 Corrosive Service Metal Components:

.1 Metal components including the fan shaft, motor pedestal, motor slide base, lube lines, accessories, hardware etc, shall be Type 316 stainless steel.

.2 Coated steel components will not be accepted.

.5 Acceptable Manufacturers:

.1 Universal Fan & Blower Ltd, ILC Series for Tubular Inline.

.2 Twin City.

.3 Hartzell.

.4 FRP Upblast Fans

.1 Housing:

.1 Windband: FRP construction, finished with smooth edge.

.2 Top Cap: FRP construction, with motor access via quick release latches.

.3 Motor completely sealed from exhaust air stream

.4 Motor cooling via air breather tubes.

.5 Integral conduit chase for wiring, vinyl coated flexible metal.

.6 Fan Inlet:

.1 Aerodynamic inlet venture, FRP construction

.2 Match wheel inlet shroud

.7 Hardware: Type 316 stainless steel.

.2 Wheel:

.1 Fibreglass using Hetron 992 FR vinylester resin

.2 Wheel shall be attached to shaft by a taperlock bushing.

.3 Backward inclined centrifugal, non-overloading type.

.4 Wheel shall match to housing inlet venturi.

.3 Shaft, Bearing, Drive:

.1 Shaft:

.1 Turned, ground and polished type 316 stainless steel

.2 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning, pillow block style.

.2 Selected for averaged life (AMBA $9L_{50}$) of not less than 200,000 hours operation at maximum catalogued operating speed.

.3 Terminate with zerk fittings

.3 Motor and Drives:

.1 Motor enclosure shall be TEFC

.2 Factory set to speed specified in Equipment Schedule

.3 Belt Driven

.4 Belts: Oil and heat resistant, nonstatic type

.4 Accessories:

.1 Disconnect: Factory installed, nonfused, NEMA 4

.2 Nameplates: Type 316 stainless steel manufacturer's nameplates

.3 Stainless steel bird screen.

.4 Corrosive Service Metal Components:

.1 Metal components including the fan shaft, motor pedestal, motor slide base, lube lines, accessories, hardware etc, shall be Type 316 stainless steel.

.2 Coated steel components will not be accepted

.5 Roof curb:

.1 Provide aluminum roof curb of 300mm in height

.2 Refer to item Prefabricated Roof Curb as specified in Section 15810, Metal Ductwork and Accessories for additional requirement.

.4 Acceptable Manufacturers:

.1 Universal Fan & Blower Ltd, Corro-Blast Centrifugal.

.2 Twin City.

.3 Hartzell

2.10 Roof Fan, Centrifugal Upblast

.1 General:

.1 Factory-assembled centrifugal upblast roof fan; including housing, fan wheel, drive assembly, motor and accessories.

.2 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Construction: Spun-formed aluminum, minimum 1.6 mm thick (16-gauge) marine alloy.

.2 Windband: Finish with rolled bead.

.3 Top Cap: Motor access via quick release latches.

.4 Motor completely sealed from exhaust air stream.

.5 Motor cooling via air breather tubes.

.6 Integral conduit chase for wiring.

.7 Drain trough at lowest point of housing.

.8 Fan Inlet:

.1 Full inlet cone of aluminum construction.

.2 Match inlet shroud.

.3 Wheel:

.1 Aluminum construction, backward inclined centrifugal, nonoverloading type.

.2 Machined, cast aluminum hub.

.3 Matched to deep spun inlet venturi.

.4 Shaft, Bearings, Drive:

.1 Shaft:

.1 Turned, ground and polished carbon steel.

.2 Keyed for sheave installation.

.3 Zinc-phosphate coated and oil emulsion-dipped.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning, pillow block style.

.2 Selected for average life (ABMA 9 L_{10}) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Terminate with zerk fittings.

.3 Drives:

.1 Factory set to specified fan revolutions per minute.

.2 Belts: Oil and heat resistant, nonstatic type.

.5 Accessories: Provide as follows:

.1 Gravity Backdraft Damper, where shown on Drawings: Gravity operation, adjustable counterweight, and aluminum construction.

.2 Bird Screens: Aluminum construction.

.3 Roof Curb:

.1 Height Above Finished Roof: 300 mm.

.2 Refer to item Prefabricated Roof Curb as specified in Section 15810, Metal Ductwork and Accessories for additional requirement.

.4 Disconnect: Factory installed, nonfused, NEMA 4.

.5 Bearing Lubrication Lines:

.1 Extended to outside of fan housing.

.2 Type 316 stainless steel construction.

.3 Terminate with zerk fittings.

.6 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Acceptable Manufacturers:

.1 Greenheck; Model CUE (Direct Drive); CUBE (Belt Drive)

.2 Cook; Model ACRUD (Direct Drive); ACRUB (Belt Drive).

.3 Penn.

2.11 Roof Gravity Ventilator, Louvered

.1 General: Factory-assembled louvered exhaust or gravity relief vent; including housing and accessories, suitable for roof mounting.

.2 Housing:

.1 Construction:

.1 Rectangular, tiered extruded aluminum construction, with welded miter cut joints, 2.7 mm (12-gauge) minimum thickness.

.2 Louvered on all four sides.

.3 Aluminum support structure, 4.4 mm (8-gauge) minimum thickness.

.2 Base:

.1 Reinforced and braced.

.2 Integral snow and storm baffle.

.3 Minimum panel thickness, 2.8 mm (12 gauge).

.4 Miter cut continuously welded curb cap corners.

.3 Hood:

.1 Overhang sufficient to provide weatherproof inlet.

.2 Minimum panel thickness, 2.0 mm (14 gauge).

.3 Anticondensate insulation coating inside hood.

.3 Accessories: Provide as follows:

.1 Gravity Backdraft Damper: Gravity operation, adjustable counterweight, aluminum construction.

.2 Bird Screen: Aluminum construction.

.3 Roof Curb:

.1 With damper tray.

.2 Insulation: Minimum 38 mm thick, 48 kg per cubic metre density, rigid mineral fibreboard insulation with metal liner.

.3 Refer to item Prefabricated Roof Curb as specified in Section 15810, Metal Ductwork and Accessories for additional requirement

.4 Inlet Screen: Removable 25 mm mesh screen of coated steel construction over exposed inlets.

.5 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Housing.

.2 Accessories.

.3 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.4 Acceptable Manufacturers:

.1 Greenheck; WRH Series

.2 Cook;

.3 Penn

2.12 Utility Blower, Centrifugal SWSI, Heavy Duty

.1 General:

.1 Factory-assembled utility blower; including housing, fan wheel, drive assembly, motor, and accessories.

.2 Suitable to convey air at temperatures up to 121 ^{o}C.

.3 Fan Performance: AMCA 99-2408 Class I.

.4 Bearing AMCA Certified Ratings Seal for sound and air performance.

.2 Housing:

.1 Material: Steel, unless as per scheduled.

.2 Construction:

.1 Curved scroll configuration, with continuous seam welding and side angle reinforcement.

.2 Lifting lugs welded to housing.

.3 Flanged and drilled outlet to permit duct connection.

.4 Drain connection located at lowest point of fan housing.

.5 Inlet: Spun-formed aerodynamic bell mouth.

.3 Base/Pedestal: All-welded heavy gauge steel.

.3 Wheel:

.1 Centrifugal, one-piece, nonoverloading, backward inclined airfoil blade type.

.2 Material: Steel, unless as per schedule.

.3 Attached to fan shaft with split taper lock bushing.

.4 Shaft, Bearings, Drive:

.1 Shafts:

.1 Turned, ground and polished steel.

.2 Ends drilled and countersunk for tachometer readings.

.3 Keyed for sheave installation.

.2 Bearings:

.1 Grease lubricated, precision antifriction ball, self-aligning type.

.2 Mounted in cast iron pillow block housing.

.3 Selected for average life (ABMA 9 L_{10}) of not less than 200,000 hours operation at maximum cataloged operating speed.

.3 Drives:

.1 Factory set to specified fan revolutions per minute.

.2 Arrangement: Arrangement 10.

.3 Belts: Oil and heat resistant, nonstatic type.

.5 Accessories: Provide as follows:

.1 Housing Access Doors: Bolted and gasketed.

.2 Disconnect: Factory installed, nonfused, NEMA 4.

.3 Flanged Inlet: Heavy gauge construction, factory drilled and flanged.

.4 Shaft Seal: Viton construction, located at shaft penetration of housing.

.5 Belt Guard: OSHA type, sheet metal construction same material as fan housing, for complete coverage of belts and sheaves.

.6 Shaft and Bearing Guard: Sheet metal construction same material as fan housing, for complete coverage of shaft and bearings.

.7 Motor and Drive Cover:

.1 Motor Enclosure shall be TEFC

.2 Factory fabricated, OSHA type.

.3 Sheet metal construction, same material as fan housing.

.4 Vented, openings sufficient size for proper motor cooling.

.8 Inlet Guard: Spiral wire type, OSHA approved, removable, same material as fan housing.

.9 Unitary Subbase:

.1 Structural metal subbase, same material as fan housing.

.2 Bolted to bottom of fan base/pedestal.

.3 Drilled for field installation of vibration isolators.

.10 Corrosion Protection Coating:

.1 Provide factory-applied corrosion protection coating on these fan components:

.1 Wheel.

.2 Housing.

.3 Accessories.

.4 Interior surfaces in contact with airstream.

.2 Coating system shall be baked polyester.

.6 Acceptable Manufacturers:

.1 Greenheck, AFSW - Airfoil or BISW – Backward Inclined

.2 Buffalo

.3 Twin City

.4 Chicago

.5 Barry Blower

.6 Northern Blower

2.13 Corrosion Protection Coating

.1 Baked Polyester:

.1 Material: Polyester.

.2 Surface Preparation: Sandblast surface to SSPC-SP 5.

.3 Application: Electrostatic spray.

.4 Curing: Oven baked at a metal temperature not to exceed 204 ^{o}C.

.5 Finished Thickness: 0.04 to 0.06 mm (1.5 to 2.5 mil) dry film thickness.

.6 Performance: Coating shall meet or exceed following criteria:

.1 Salt Spray Test: Minimum 1,000-hour duration, ASTM B117 test method.

.2 Humidity Resistance: Minimum 1,000-hour duration, ASTM D2247 test method.

.3 Impact Resistance: 1.10 cm-N (10 inch-pounds), ASTM D2794 test method.

.4 Pencil Hardness: 2H, ASTM D3363 test method.

.5 UV Resistance: UV inhibited life of minimum 10 years when exposed to sun in State of Florida.

.6 Service Temperature: Maximum 110 ^{o}C, continuous.

2.14 Motors

.1 General:

.1 Fan motors shall comply with Section 15010, General Mechanical Provisions.

.2 Provide integral self-resetting overload protection on single-phase motors.

.3 Motors for fans specified for use with variable frequency drives shall be inverter duty type. Provide variable frequency drives in accordance with the requirements of Section 16815, Variable Frequency Drives.

.4 Motors shall not operate into service factor in any case.

.2 Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

.1 Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

.2 Winding Thermal Protection: None.

.3 Space Heater: No.

.4 Number of Speeds: Single.

.5 Number of Windings: One, two for two speed motor.

.6 Motor Efficiency: As per Section 15010, General Mechanical Provisions.

.7 Shaft Type: Solid, carbon steel.

.8 Mounting: As required for fan arrangement.

.9 Service Factor: 1.15.

2.15 Accessories

.1 Equipment Identification Plates: Furnish 1.6 mm (16-gauge) stainless steel identification plate securely mounted on each separate equipment in a readily visible location. Plate shall bear 10mm high engraved block type black enamel filled equipment identification number and letters as shown on drawings.

.2 Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 45 kg.

2.16 Source Quality Control

.1 General:

.1 Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.

.2 Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.

.3 Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

.2 Testing Provisions:

.1 Provide tachometer access holes large enough to accept standard tachometer drive shaft.

.2 Center punch fan shaft to accommodate tachometer readings.

.3 Acoustical Levels:

.1 Perform noise tests in accordance with AMCA 300 and AMCA 301.

.2 Fan sound power levels (dB, Reference 10^{-12} Watts) shall be no greater than scheduled values.

.4 Balancing:

.1 Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ANSI S2.19 Grade G6.3.

.2 Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

.5 Vibration Test:

.1 Each fan furnished with a 3.7 kW or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.

.2 Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:

.1 Belt Drive (except Vane Axial): 0.38 cm per second peak velocity.

.2 Belt Drive Vane Axial: 0.2 cm per second peak velocity.

.3 Direct Drive: 0.2 cm per second peak velocity.

.3 Written records of run test and vibration test shall be made available upon request.

3. EXECUTION

3.1 Installation

.1 Install fans level and plumb.

.2 Secure roof-mounted fans to roof curbs with Type 316 stainless steel hardware.

.3 Ceiling Units: Suspend units from structure; use steel wire or metal straps.

.4 Scroll Drains: Pipe drain connection through running trap to floor drain.

.5 Labeling:

.1 Label fans in accordance with Article, Accessories.

.2 Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

.6 Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

.7 Connections:

.1 Refer to Section 15810, Metal Ductwork and Accessories and 15815, FRP Ductwork and Accessories.

.2 Isolate duct connections to fans.

.3 Install ductwork adjacent to fans to allow proper service and maintenance.

3.2 Field Quality Control

.1 Functional Tests:

.1 Verify blocking and bracing used during shipping are removed.

.2 Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.

.3 Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.

.4 Verify that cleaning and adjusting are complete.

.5 Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.

.6 Reconnect fan drive system; align and adjust belts and install belt guards.

.7 Verify lubrication for bearings and other moving parts.

.8 Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

.2 Performance Tests:

.1 Starting Procedures:

.1 Energize motor and adjust fan to indicated revolutions per minute.

.2 Measure and record motor voltage and amperage.

.2 Operational Test:

.1 After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

.2 Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.

.3 Test and adjust control safeties.

.4 Replace damaged and malfunctioning controls and equipment.

3.3 Manufacturer's Services

.1 Provide manufacturer's representative at site in accordance with Section 01650 - Equipment Installation, for installation assistance, inspection and certification of installation, equipment testing, startup assistance, and training of City's personnel for specified component, subsystem, equipment, or system.

3.4 Adjusting

.1 Adjust damper linkages for proper damper operation.

.2 Adjust belt tension.

.3 Lubricate bearings.

.4 Balancing:

.1 Perform air system balancing as specified in Section 15950, HVAC Systems Testing, Adjusting, and Balancing.

.2 Replace fan and motor sheaves as required to achieve design airflow.

3.5 Cleaning

.1 After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

.2 On completion of installation, internally clean fans according to manufacturers' written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

3.6 Supplements

.1 The supplements listed below, following "End of Section," are a part of this Specification.

.1 15830-01, Exhaust Fan Schedule

.2 15830-02, Roof -Gravity Ventilator Schedule.

END OF SECTION

EXHAUST FAN (EF) SCHEDULE
15830-01

EQUIPMENT TAG	AREA SERVED	FAN TYPE	FAN DATA			MOTOR DATA				PHYSICAL DATA				MANUFACTURER AND MODEL NO.	REMARKS
			CAPACITY		SPEED					WEIGHT	DIMENSIONS mm				
			L/s	E.S.P.	RPM										
				Pa		kW	RPM	VOLT	PH	kg	L	W	H		
EF-H002	Pipe Gallery Ventilation	Utility Blower	5,377	188	552	2.24	1725	575	3	455	1753	1657	1614	Greenheck: 36-AFSW-21	
EF-H003	Effluent Gate Room	Square Inline	896	125	1878	0.56	1725	575	3	43	533	483	483	Greenheck: BSQ-120-7	
EF-H004	Filter Gallery Exhaust	Utility Blower	5,660	188	552	2.24	1725	575	3	455	1753	1657	1614	Greenheck: 36-AFSW-21	
EF-H005	Chemical Feed Area Exhaust	FRP Inline	283	125	1690	0.37	1725	115	1	50	600	483	483	Universal: ILC-10	
EF-H006	Ozone Mixing Chamber Exhaust	Roof Upblast	71	63	1472	0.02	1472	115	1	13	467	467	343	Greenheck: CUE-065-D	(1)
EF-H013	Pilot Plant Room Exhaust	Utility Blower	2,642	188	1398	1.49	1725	575	3	140	1153	956	1048	Greenheck: 20-AFSW-21	
EF-H014	Residual Room Exhaust	Utility Blower	6,934	188	620	3.73	1725	575	3	454	1584	1754	1614	Greenheck: 36-AFSW-21	
EF-H015	Mechanical Room No.2 Exhaust	Square Inline	6,038	188	806	3.73	1725	575	3	191	1041	1168	1168	Greenheck:BSQ-300-50	
EF-H023	Ozone Gen. Rm Emerge. Exhaust	Utility Blower	10,660	188	652	7.46	1725	575	3	555	1737	1737	2016	Greenheck:40-BISW-21	(3),(6)
EF-H024	Access Corridor No. 3 Exhaust	Square Inline	1,038	188	1445	0.56	1725	575	3	64	559	584	584	Greenheck:BSQ-140-7	
EF-H025	Access Corridor No. 2 Exhaust	Square Inline	472	188	1676	0.25	1725	115	1	39	533	432	432	Greenheck:BSQ-100-3	
EF-H037	Polymer Storage Room Exhaust	Roof Upblast	2,358	188	1099	1.12	1725	575	3	65	899	899	727	Greenheck: CUBE-200-15	
EF-H038	Peroxide Storage Room Exhaust	FRP Upblast	1,038	125	965	0.56	1725	575	3	80	980	980	765	Universal: CB-18	(2)
EF-H039	SBS Storage Room Exhaust	FRP Upblast	1,321	125	1125	0.75	1725	575	3	80	980	980	765	Universal: CB-18	(2)
EF-H040	Blower Room Ventilation	Square Inline	802	125	1958	0.56	1725	575	3	43	533	483	483	Greenheck:BSQ-120-7	
EF-H041	Mechanical Room No.3 Exhaust	Square Inline	283	125	1808	0.19	1725	115	1	34	533	381	381	Greenheck:BSQ-80-4	
EF-H043	Maintenance Washrms Exhaust	Roof Upblast	106	188	1436	0.19	1725	115	1	26	600	600	1100	Greenheck:CUBE-101HP-4	
EF-H044	Waste Storage Exhaust	Square Inline	189	188	1636	0.19	1725	115	1	34	533	381	381	Greenheck:BSQ-80-4	
EF-H052	DAF Process Gallery Exhaust	Utility Blower	12,877	188	405	11.19	1725	575	3	1023	2219	2575	2310	Greenheck: 54-AFSW-21	
EF-H053	DAF Pump Gallery Transfer	Square Inline	8,962	440	668	7.46	1725	575	3	327	1270	1473	1473	Greenheck:BSQ-420-100	
EF-H063	Fire Pump Room Normal Exhaust	Square Inline	142	125	1899	0.19	1725	115	1	34	533	381	381	Greenheck:BSQ-70-5	
EF-H064	Mechanical Room No.1 Exhaust	Square Inline	189	125	2222	0.37	1725	115	1	34	533	381	381	Greenheck:BSQ-70-5	(4)
EF-H065	Fire Pump Rm HR Exhaust	Square Inline	1,509	125	1257	0.56	1725	575	3	73	660	660	660	Greenheck:BSQ-160-7	
EF-H066	Control Room Washroom Exhaust	Cabinet Ceiling	35	63	950	50 W	700	115	1	7	270	337	267	Greenheck:SP-A110	(1)
EF-H067	Electrical Closet Exhaust	Square Inline	189	188	1450	0.19	1,725	115	1	34	533	381	381	Greenheck:BSQ-70-5	
EF-H072	Admin. Area Fume Hood Exhaust	Roof Upblast	189	250	1168	0.19	1725	115	1	26	632	632	441	Greenheck: CUBE-101-4	
EF-H073	Admin. Area Sanitary Exhaust	Square Inline	731	250	1666	0.56	1725	575	3	50	533	533	533	Greenheck:BSQ-130-7	
EF-H074	Mechanical Room No.4 Exhaust	Square Inline	189	125	2222	0.37	1725	115	1	34	533	381	381	Greenheck:BSQ-70-5	(4)
EF-H075	Admin Area 3rd Level Exhaust	Square Inline	1,050	125	1083	0.37	1,725	115	1	73	660	660	660	Greenheck:BSQ-160-5	(5)
EF-H076	Admin Area 2nd Level Exhaust	Square Inline	472	188	1356	0.19	1,725	115	1	43	533	483	483	Greenheck:BSQ-120-4	(5)

REMARKS:

1 Direct drive with mounted solid state speed controller. Other are belt drive
2 Two speed, 2 windings. 50% speed reduction ratio
3 Stainless Steel Construction & Shaft
4 Safety Inlet Screen
5 Variable Frequency Drive
6 Structural based suitable for outdoor application

ROOF GRAVITY VENTILATOR (GV) SCHEDULE
15830-02

EQUIPMENT TAG	AREA SERVED	PERFORMANCE DATA			THROAT DIMENSION		ROOF OPENING		PHYSICAL DATA					MANUFACTURER AND MODEL NO.	REMARKS
		AIRFLOW	PRESURE DROP	THROAT VELOCITY	LENGTH	WIDTH	LENGTH	WIDTH	LOUVERS HIGH	DIMENSIONS mm			WEIGHT		
		[L/s]	[Pa]	[m/s]	[mm]	[mm]	[mm]	[mm]		L	W	H	[kg]		
GV-H060A	RWP Room Relief	2,264	14	3.00	914	813	723.90	876	5	1270	1168	502	43	Greenheck: WRH	1-7
GV-H060B	RWP Room Relief	2,264	14	3.00	914	813	723.90	876	5	1270	1168	502	43	Greenheck: WRH	1-7
GV-H060C	RWP Room Relief	2,264	14	3.00	914	813	723.90	876	5	1270	1168	502	43	Greenheck: WRH	1-7
GV-H061	Electrical Room No. 1 Relief	1,509	13	2.94	711	711	774.70	775	4	1067	1067	406	31	Greenheck: WRH	1-7
GV-H030	Electrical Room No. 2 Relief	1,132	14	3.00	610	610	673.10	673	4	965	965	406	27	Greenheck: WRH	1-7

REMARKS:

1 ALUMINUM BIRDSCREEN
2 HI-PRO POLYESTER - IVORY, ENTIRE UNIT
3 ALUMINUM HOUSING
4 ALUMINUM CURB, GPI-A24, TRAY
5 RUBBER CURB CAP STRIPPING
6 GRAVITY RELIEF DAMPER COMPLETE WITH COUNTER BALANCING
7 25mm THICK HOOD INSULATION

AIR OUTLETS AND INLETS

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 UL: Product Directories.

.2 ULC.

1.2 Submittals

.1 Action Submittal:

.1 Shop Drawings:

.1 Manufacturer's data and descriptive literature for products specified.

.2 Furnish the following information for each type of diffuser, register, and grille furnished.

.1 NC sound data.

.2 Static pressure loss data.

.3 Throw data.

.2 Informational Submittals: List of recommended spare parts for products specified.

2. PRODUCTS

2.1 Ceiling Diffusers

.1 Square and Rectangular CD:

.1 600 x 600 or 300 x 300 Square Ceiling Diffusers as shown on drawings.

.2 Aluminum construction.

.3 Removable core section of louvers.

.4 Round neck.

.5 Continuous sponge rubber gasket at face flange.

.6 Acceptable Manufacturers:

.1 E.H. Price, Model SDMA.

.2 Titus

.3 Nailor

.2 LD:

.1 Rectangular aluminum construction.

.2 Extruded 25 mm flat slotted frame with concealed fasteners.

.3 Concealed swing type adjustable deflector blades.

.4 Single 25 mm slot.

.5 Continuous sponge rubber gasket at face flange.

.6 Baked white enamel finish.

.7 Flat black deflector blade.

.8 Furnish with 12 mm internally lined 1200 mm plenum with side inlet duct collar.

.9 Acceptable Manufacturers:

.1 E.H. Price , Model SDAI100.

.2 Titus

.3 Nailor

2.2 Supply Grilles and Registers

.1 WSG:

.1 Rectangular aluminum construction.

.2 Adjustable front horizontal and rear vertical vanes on 20 mm centers.

.3 Continuous sponge rubber gasket at face flange.

.4 25 mm minimum flat aluminum frame.

.5 White Powder coat finish.

.6 Acceptable Manufacturers:

.1 E.H. Price , Model 620.

.2 Titus

.3 Nailor

.2 WSR:

.1 Rectangular aluminum construction. Stainless steel construction where stainless steel ductwork is required.

.2 Individually adjustable horizontal face and vertical rear louver fins.

.3 Gang-operated opposed-blade horizontal volume control damper.

.4 Continuous sponge rubber gasket at face flange.

.5 25 mm flat aluminum frame. Stainless steel where stainless steel ductwork is required.

.6 White Powder coat finish.

.7 Acceptable Manufacturers:

.1 E.H. Price, Model 620 DAL (Aluminum), 720 DAL (Stainless Steel)..

.2 Titus

.3 Nailor

.3 HTR:

.1 Industrial grade.

.2 Aluminum construction.

.3 Rotatable aluminum barrel with individually adjustable lateral diffusing vanes.

.4 Gang-operated opposed-blade vertical volume control damper.

.5 Mounting collar for direct attachment to ductwork.

.6 Continuous sponge rubber gasket at face flange.

.7 Aluminum Powder Coated finish.

.8 Acceptable Manufacturers:

.1 E.H. Price, Model HCDID.

.2 Titus

.3 Nailor

2.3 Return and Exhaust Grilles And Registers

.1 WG:

.1 Rectangular aluminum construction. Stainless steel for locating inside Ozone Generator Room.

.2 Fixed horizontal louvers set at 35 to 45 degrees.

.3 25 mm minimum flat aluminum frame. Stainless steel for locating inside Ozone Generator Room.

.4 White Powder Coat finish.

.5 Acceptable Manufacturers:

.1 E.H. Price , Model 630 (Aluminum), 730 (Stainless Steel).

.2 Titus

.3 Nailor

.2 WR:

.1 Rectangular aluminum construction. Stainless steel where stainless steel ductwork is required.

.2 Fixed horizontal louvers set at 35 to 45 degrees.

.3 Gang-operated opposed-blade volume control damper.

.4 25 mm flat aluminum frame. Stainless steel where stainless steel duct work is required.

.5 White Powder Coat finish.

.6 Acceptable Manufacturers:

.1 E.H. Price , Model 630 DAL (Aluminum), 730D (Stainless steel).

.2 Titus

.3 Nailor

.3 HCG:

.1 Square aluminum eggcrate construction.

.2 Extruded 32 mm flat frame with concealed fasteners.

.3 Fixed 12 mm by 12 mm by 12 mm louvers.

.4 Baked white enamel finished frame.

.5 Acceptable Manufacturers:

.1 E.H. Price , Model 80.

.2 Titus

.3 Nailor

3. EXECUTION

3.1 Installation

.1 Install diffusers, grilles, and registers tight on their respective mounting surfaces, level, plumb, and true with room dimensions.

.2 Provide appropriate frame to adapt to mounting surface.

END OF SECTION

HVAC INSTRUMENTATION AND CONTROLS - GENERAL

1. GENERAL

1.1 References

.1 The following is a list of standards which may be referenced in this section:

.1 ANSI: X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.2 ASHRAE:

.1 Handbook of Fundamentals.

.2 Guideline 3, Reducing Emission of Fully Halogenated Refrigerants in Refrigeration and Air-Conditioning Equipment and Systems.

.3 135, Data Communication Protocol for Building Automation and Control Networks.

.3 ASME: B19.3, Safety Standard for Compressors for Process Industries.

.4 AWWA: C704, Propeller-Type Meters for Waterworks Applications.

.5 EIA:

.1 TIA-232-F, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.

.2 485, Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.

.6 FM.

.7 ISO: 8802-3, Information Technology - Telecommunication and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements - CSMA/CD Access Method and Physical Layer Specifications.

.8 NEMA: 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

.9 NFPA:

.1 70, National Electric Code.

.2 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

.10 UL: 916, Standard for Safety Energy Management Equipment.

.11 ULC.

.12 National Building Code.

.13 National Fire Code.

.14 CSA.

1.2 Definitions

.1 The terms "HVAC Control System," "Automatic Temperature Control System," "Building Automation System," and "Environmental Management and Control System" shall be considered equivalent and used interchangeably for the purposes of this Contract.

.2 Algorithm: A software procedure for solving a recurrent mathematical or logical problem.

.3 Analog: A continuously varying signal or value (temperature, current, velocity, etc.).

.4 Binary: A two-state system where an "ON" condition is represented by a high signal level and an "OFF" condition is represented by a low signal level.

.5 Control Wiring:

.1 Wiring, high or low voltage other than power wiring required for proper operation of a system.

.2 Includes conduit, wire and wiring devices to install complete control system including motor control circuits, interlocks, thermostats and like devices.

.3 Includes wiring from DDC cabinet to all sensors and points specified herein and required to execute sequence of operation.

.4 Includes necessary power wiring to HVAC control devices, digital controllers including terminal units and actuators. Refer to Supplemental Conditions, Part D, for Scope of Work.

.6 Control Process: Software required to complete control loop from input signal to interlock logic and process calculation to final output signal control.

.7 Deadband: Temperature range over which no heating or cooling energy is supplied, such as 22 to 25 ^{o}C; as opposed to single point changeover or overlap, or a range from set point over which no control action is taken.

.8 DDC: Consists of microprocessor-based controllers with control logic performed by software. A/D converters transform analog values into digital signals that microprocessor can use.

.9 Power Wiring: Line voltage wiring to mechanical equipment. Line voltage wiring that also serves as control circuit, such as line voltage thermostat or involves interlocking with

damper shall be considered control wiring. Refer to Supplemental Conditions, Part D, for Scope of Work.

.10 Abbreviations that may be used in this section:

.1 ATC: Automatic Temperature Control.

.2 BAS: Building Automation System.

.3 CWS/R: Cooling Water Supply/Return.

.4 CMOS: Complementary Metal Oxide Semiconductor.

.5 DB: Dry Bulb Temperature.

.6 DDC: Direct Digital Control.

.7 DX: Direct Expansion.

.8 EEPROM: Electronic Erasable Programmable Read Only Memory.

.9 EMCS: Environmental Management and Control System.

.10 HCP: HVAC Control Panel.

.11 CDS/R: Condenser Water Supply/Return.

.12 HMI: Human-Machine Interface.

.13 HOC: Hand-Off-Computer (Switch).

.14 HVAC: Heating, Ventilation, and Air Conditioning.

.15 IP: Current (I) - Pressure (P), as in IP transducer.

.16 LCD: Liquid Crystal Display.

.17 LED: Light Emitting Diode.

.18 PLC: Programmable Logic Controller.

.19 RAM: Random Access Memory.

.20 RTD: Resistance Temperature Detectors.

.21 WB: Wet Bulb Temperature.

1.3 System Description

.1 General Requirements:

.1 Provide control wiring, power wiring, conduit, hardware, and electrical work associated with the HVAC control system as specified in Part D.

.2 Provide control wiring between HVAC control panel contacts and field control devices, such as duct smoke detectors and motor starter control coil contacts.

.3 Provide controls necessary for entire system to have fail-safe operation.

.4 Refer to Section 15900-01 – Typical Control Sequences for control sequences and functions including alarms, monitoring and resetting functions, and operational sequences.

.5 Provide sequences and functions as required to deliver a fully functioning HVAC system.

.2 Control System Types:

.1 The following control system shall be used in the performance of the Work.

.1 NETWORKED DDC:

.1 Microprocessor-based DDC Control System utilizing standalone DDC controllers.

.2 Information within control system can be utilized by any control component over high-speed network.

.3 User interface via computer workstation and/or portable terminal.

.4 Refer to Section 15902, Microelectronic Control Components, for additional requirements.

.2 Electric/Electronic Control System (ELECTRIC)

.1 System using simple electric or electronic control devices

.2 User interface at control device.

.2 Provide control systems of architecture as follows:

.1 NETWORKED DDC:

.1 All systems except those indicated as ELECTRIC control type.

.2 ELECTRIC:

.1 All Gas-fired unit heaters (GUH)

.2 All Electric unit heaters (EUH)

.3 All Electric Convectors (EC) controlled by remote thermostats

.4 EF-H066 and EF-H072.

.3 Performance Requirements: Design control system and equipment to perform under the following conditions:

.1 Temperature, Ambient:

.1 Summer maximum 30 DB/22 WB ^{0}C.

.2 Winter minimum 5 DB ^{o}C.

.3 Based on ASHRAE Handbook Fundamentals weather data for the City of Winnipeg, Manitoba.

.2 Temperature, Indoor:

.1 Heated and Ventilated Process Areas: Summer maximum 39 ^{o}C; Winter minimum 10 ^{o}C.

.2 Air-conditioned Nonprocess Areas: Summer maximum 24 ^{o}C; Winter minimum 21 ^{o}C.

.4 Refer to Section 01600, Material and Equipment, for additional environmental performance requirements.

1.4 Submittals

.1 Action Submittals:

.1 Shop Drawings:

.1 Complete specifications, descriptive drawings, catalog cuts, and descriptive literature that includes make, model, dimensions, weight of equipment, and electrical schematics, for all control system components.

.2 Complete system power, interlock, control, and data transmission wiring diagrams no smaller than 280 mm by 432 mm.

.3 Complete drawings and schematics of proposed control system, including panel power requirements.

.4 System operating sequences to be programmed, in exact English language.

.5 Complete points list.

.6 Interfaces with HVAC equipment.

.1 Schematic diagram of each equipment item.

.2 Indicate location of each control item in equipment.

.3 Show equipment manufacturer controls where installed.

.7 Panel face layout drawings.

.2 Information Submittals:

.1 Table identifying which member of Contractor's team is responsible for furnishing and setting in-place power wiring and control wiring of each item or component of HVAC equipment.

.2 Recommended procedures for protection and handling of equipment and materials prior to installation.

.3 Certificates as per Section 01650, Equipment Installation:

.1 Certificate of Satisfactory Installation.

.2 Certificate of Equipment Satisfactory Performance.

.4 Draft maintenance agreement.

.5 Confirmation that control system Subcontractor has received, and coordinated with all approved HVAC equipment submittals.

.6 Experience and qualifications of control system Subcontractor's proposed representative who shall supervise installation, adjustment, and calibration of control systems.

.7 Performance test plan and schedule.

.8 Test Results:

.1 Functional and performance test documentation.

.2 Component calibration sheets for each instrument and panel component.

.9 Operation and maintenance data, include the following detailed information:

.1 Operation and maintenance instructions for control system as furnished and installed, including control of associated mechanical and electrical equipment.

.2 Record of system adjustments and calibration methods.

.3 Performance test results.

1.5 Quality Assurance

.1 Materials, devices, appliances, and equipment used shall be indicated as acceptable by established standards of UL, ULC and CSA.

.2 Codes and Standards: Meet requirements of applicable standards and codes, except when more detailed or stringent requirements are indicated by Contract Documents, including requirements of this section.

.1 Underwriters Laboratories: Products shall be UL 916-PAZX listed and ULC listed.

.2 Canadian Electrical Code (CEC).

.3 Networked DDC Control Systems shall comply with ASHRAE 135 (BACnet).

.3 Qualifications of HVAC Subcontractor:

.1 Minimum of 15 years' experience in design, installation, and maintenance of fully electronic building automation systems.

.2 Minimum of 10 years' experience in design, installation, and maintenance of computer based, direct digital control, facility automation systems.

.3 Minimum of 5 years' experience as manufacturer's authorized representative in design, installation, and maintenance of manufacturer's system and products.

.4 Capable of furnishing factory-trained technicians, competent to provide instruction, routine maintenance, and emergency service onsite within 4 hours after receipt of request.

.5 Factory trained certified engineering and Performance Verification staff, and complete offsite training facilities.

.6 Necessary facilities to provide City with complete maintenance, periodic inspection, and service contract. Refer to Paragraph, Maintenance.

.4 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of 15 years. Future compatibility shall be supported for no less than 10 years.

.2 Compatibility shall be determined as:

.1 Ability to upgrade existing field panels to current level of technology, and extend new field panels on previously installed network.

.2 Ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers, or protocol converters.

1.6 Delivery, Storage, and Handling

.1 Comply with Section 01600, Material and Equipment.

.2 Corrosion Protection:

.1 Control panels, enclosures, and other equipment containing electrical or instrumentation and control devices, including spare parts, shall be protected from corrosion through use of corrosion-inhibiting vapour capsules.

.2 Prior to shipment, capsules shall be provided within shipping containers and equipment as recommended by capsule manufacturer.

.3 During construction period, capsules shall be replaced in accordance with capsule manufacturer's recommendations.

1.7 Maintenance

.1 Maintenance Service Agreement:

.1 Furnish a draft maintenance agreement, prepared and signed by the controls Subcontractor to provide the necessary preventive maintenance to keep the various control systems in proper working condition.

.2 Fully describe the maintenance work to be performed and estimate cost of the maintenance during the 1-year correction period and the subsequent year.

.3 This service contract shall include 24-hour emergency service, 7 days per week.

2. PRODUCTS

2.1 Manufacturers

.1 Materials, equipment, and accessories specified shall be products of the following manufacturers, unless indicated otherwise:

.1 Honeywell

.2 Landis Division of Siemens Building Technology, Inc.

.3 Johnson Controls.

2.2 Materials

.1 General:

.1 Products used in this installation shall be new, currently under manufacture, and shall have been applied in similar installations for minimum of 2 years.

.2 System shall not be used as test Site for new products, unless explicitly approved by Contract Administrator, in writing.

.2 Control Components:

.1 Control range to obtain specified capacities.

.2 Sensitivity to maintain control points close enough to set point for acceptable offset, without cycling equipment more frequently than recommended by manufacturer.

.3 Field or computer adjustable to actual set point, ranges. Adjustable to other settings that will provide proper operation of entire control system.

.3 Controls Interfacing:

.1 Interface controls properly with factory supplied components of mechanical systems. Coordinate special control interfacing requirements.

.2 For equipment that requires special interfacing with control system, provide equipment with integral controls or provide accessory devices required for operation of total mechanical system.

.3 Coordinate interfaces with electrical work as necessary.

.4 Provide electric, electronic, and mechanical devices as required to properly interface with prewired control panels furnished with HVAC equipment and with other mechanical and electrical components.

2.3 Labeling

.1 All products, namely electrical materials, devices, appliances, and equipment used, shall be indicated as acceptable by established standards of UL, ULC, FM and CSA.

.2 Valid label affixed to item shall provide indication of product acceptance by required agencies.

.3 HVAC control panels and control components that consist of multiple components shall bear UL, ULC and CSA listing mark on unit.

2.4 Service Conditions

.1 Refer to Section 01600, Material and Equipment, Section 16010, Basic Electrical Requirements, and Electrical Drawings for classification of areas as hazardous, corrosive, wet, indoor dry, and dust-tight.

.2 Use materials and methods, and enclose devices in NEMA enclosure types suitable for classification indicated, and as required by CEC.

.3 Exhaust ductwork shall be considered same classification as area served.

.4 Instruments within 900 mm of ducts conveying air from spaces classified as Class I, Zone 1 or 2 (in accordance with CEC) shall be suitable for same area classification as space exhausted.

2.5 Electrical Components and Accessories

.1 Electrical components shall be provided in accordance with requirements of Division 16, Electrical.

.2 Wiring:

.1 In accordance with NFPA 70.

.2 Insulation shall be rated 600 volts, minimum.

.3 Electrical Raceways: In accordance with NFPA 70.

.4 Provide surge suppressors on each power connection.

2.6 Field Components and Instruments

.1 Refer to HVAC controls detailed specification, Section 15901, HVAC Controls, Field Components, and Instruments.

2.7 Microelectronic Control Components

.1 Refer to HVAC controls detailed specification, Section 15902, Microelectronic Control Components.

2.8 Accessories

.1 Corrosion-inhibiting vapor capsules as manufactured by:

.1 Northern Instruments; Model Zerust VC.

.2 Hoffman; Model A-HCI

.2 Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 45 kg.

.3 Equipment Identification Plates:

.1 Provide 1.6 mm (16-gauge) type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 9.5mm high engraved block type black enamel filled equipment identification number and letters indicated in this Specification and as shown.

.2 Provide adjacent to the following control devices, and for equipment whose function is not readily apparent.

.1 Manual override switches.

.2 Ventilation Mode switches.

.3 Special purpose devices.

.4 HVAC control panels.

.4 Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer.

2.9 Equipment Finish

.1 Provide materials and equipment with manufacturer's standard finish system. Provide manufacturer's standard finish colour, except where specific color is indicated.

.2 If manufacturer has no standard colour, provide gray finish as approved by Contract Administrator.

3. EXECUTION

3.1 Sequences of Operation

.1 Refer to the following Sections for detailed description of system sequence of operation:

.1 15900-01 Typical Control Sequences.

.2 15900-02 MAU-H001, Filter Gallery HV Control System.

.3 15900-03 MAU-H011, Pilot Plant HV Control System.

.4 15900-04 MAU-H012, Wash-water Recovery Gallery HV Control System.

.5 15900-05 MAU-H021, Ozone Generator Room Emergency HV Control System.

.6 15900-06 MAU-H031, Polymer Preparation & Storage Rm HV Control System.

.7 15900-07 MAU-H032, Peroxide Feed and Storage Room HV Control System.

.8 15900-08 MAU-H033, SBS Feed and Storage Room HV Control System.

.9 15900-09 MAU-H051, DAF Process Gallery HV Control System.

.10 15900-10 AHU-H035, Electrical Room No. 2 Heat Relief Control System.

.11 15900-11 AHU-H061, Raw Water Pump Room Heat Relief Control System.

.12 15900-12 AHU-H062, Electrical Room No. 1 Heat Relief Control System.

.13 15900-13 AHU-H071, Administration Area HVAC Control System.

.14 15900-14 HRU-H022, Ozone Generator Room General HV Control System.

.15 15900-15 HRU-H034, Maintenance Workshop Area HV Control System.

.16 15900-16 Water Source Heat Pump Control System.

.17 15900-17 Cooling Water and Condenser Water Control System.

.18 15900-18 Simple Exhaust Fans Control Systems.

.19 15900-19 EF-H015, Mechanical Room No. 2 Heat Relief Control System.

.20 15900-20 EF-H041, Mechanical Room No. 3 Heat Relief Control System.

.21 15900-21 EF-H043, Maintenance Area Washroom Exhaust Control System.

.22 15900-22 EF-H063, Fire Pump Room Ventilation Control System.

.23 15900-23 EF-H064, Mechanical Room No. 1 Heat Relief Control System.

.24 15900-24 EF-H073, Administration Area Sanitary Exhaust Control System.

.25 15900-25 EF-H074, Mechanical Room No. 4 Heat Relief Control System.

.26 15900-26 EF-H067, Admin. Area Electrical Close Heat Relief Control System.

.27 15900-27 Electric Radiant Birdscreen Defrosting Control System.

3.2 Installation

.1 General:

.1 Install systems and materials in accordance with manufacturer's instructions, rough-in drawings, and equipment details.

.2 Changes in location or installation of control devices or equipment shall be approved by Contract Administrator before proceeding with the Work.

.3 Mount devices requiring manual reset and all other user serviceable control devices in readily accessible locations.

.2 Hazardous and Corrosive Areas:

.1 Control equipment and wiring shall be suitable for classification as specified in Division 16.

.2 Protect control equipment located in areas identified as being corrosive as follows:

.1 Use corrosion-inhibiting vapour capsules.

.2 Replace capsules prior to Substantial Performance.

.3 Wiring:

.1 General:

.1 Install electric wire, cable, fittings, and conduit associated with systems specified in this section, in accordance with requirements of CEC.

.2 Install control and interlock wiring separate from power wiring.

.3 Number code or colour code conductors, excluding those used for individual zone controls, appropriately for future identification and servicing of control system.

.4 Provide wire markers on each conductor in panel and at load connections. Identify circuit with control wire number.

.5 Restrain wiring in control panels by plastic ties or ducts.

.6 Hinge wiring shall be secured at each end so that any bending or twisting will be around longitudinal axis of wire and bend area shall be protected with sleeve.

.7 Arrange wiring neatly, cut to length, and remove surplus wiring. Provide abrasion protection for any wire bundles that pass through holes or across edges of sheet metal.

.8 Use manufacturer's recommended tool with proper sized anvil for crimp terminations. No more than two wires may be terminated in single crimp lug and no more than two lugs may be installed on single screw terminal.

.9 Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

.10 Properly support and run wiring in a neat manner.

.11 Run wiring parallel or at right angles to building structure.

.12 Generally conceal wiring from view, except in mechanical rooms and areas where other conduit and piping are exposed; install exposed wiring and conduit to be as unobtrusive as possible.

.13 Install line voltage control wiring, wiring exposed to view, surface-mounted wiring, and wiring concealed within walls in conduit, in accordance with Division 16, Electrical.

.14 Install exposed and concealed low voltage control wiring systems in conduit.

.15 Wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

.16 Conduit shall be sized to suit the number, type, and size of conductors as specified in Section 16125, Wires, Cables and Hardware up to 1000V.

.4 End-User Accessible Control Components:

.1 Do not mark room thermostats.

.2 Mount user adjustable control components (room thermostats, humidistats, temperature sensors, humidity sensors, etc.) level and in accordance with applicable accessibility requirements of local Building Code.

.5 Control Valves:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control valves by means of associated controller.

.6 Control Dampers:

.1 Verify correctness of installation.

.2 Verify proper control action.

.3 Adjust limit switch settings.

.4 Adjust opening and closing speeds, and travel stops.

.5 Stroke control dampers by means of associated control output.

.7 Adjustable Frequency Drives:

.1 Verify control wiring installed to adjustable frequency drive.

.2 Calibrate and adjust remote speed control loop and feedback loop.

.3 Verify control actions and interlocks.

.4 Adjust minimum and maximum speed settings.

.5 Ramp adjustable frequency drive by simulation of associated controller output.

.8 DDC Controllers:

.1 Verify control wiring for correctness.

.2 Verify power wiring.

.3 Calibrate and adjust manual and auto control actions of controllers.

.4 Tune control loop.

.5 Stroke associated final element through controller output.

.6 Verify set points and alarm functions.

3.3 Field Quality Control

.1 Performance and Functional Testing:

.1 Tests and certification shall be as specified in Section 01650, Equipment Installation and Section 01670 - Commissioning.

.2 HVAC controls interface with process control system shall be coordinated with the Work of Section 17500 - Programmable Logic Controllers.

3.4 Training

.1 Provide training of City's personnel for duration and number of trips as specified in Section 01664 - Training. Provide training personnel for a minimum of 4 business days, or more if required to meet number of training events.

.2 Provide training of City's personnel to enable them to operate HVAC equipment in available modes, to adjust set points, and to interpret alarm signals.

.3 Training sessions shall be prepared in advance, and arranged for clear, effective transfer of information in minimum time.

3.5 Adjusting and Calibrating

.1 Control system shall be adjusted and calibrated by qualified manufacturer's representative.

.2 Calibrate control devices at time of installation to ensure measuring and reading accuracy.

.3 Adjustment Record:

.1 Prepare complete record of system adjustments for each control system.

.2 Indicate deviations from specified temperatures.

.3 Include copy of completed record in each copy of Operation and Maintenance Manual.

3.6 Cleaning and Touchup Painting

.1 Touchup scratches, scrapes, or chips in exterior surfaces with finish matching type, colour, consistency, and type of surface of original finish.

END OF SECTION

TYPICAL CONTROL SEQUENCES

.1 MOTORIZED DAMPER AND FAN INTERLOCK CONTROL:

.1 When fan is commanded to start, first open its associated damper.
.2 Provide end switch for open position of each damper.
.3 Once damper is proved fully open, start respective fan.
.4 Damper end switches shall stop respective fan if damper begins to close.
.5 Close damper on fan shutdown.

.2 MOTORIZED DAMPER AND EMERGENCY FAN INTERLOCK CONTROL (OZONE EMERGENCY VENTILATION SYSTEM):

.1 Associated damper shall be wired with power to close and spring to open configuration.
.2 When fan is commanded to start, first de-energize its associated damper actuator(s).
.3 Provide end switch for open position of each damper.
.4 Once damper is proved fully open, start respective fan.
.5 When fan is commanded to stop, first de-energize the fan then energize its associated damper actuator(s).
.6 Close damper on fan shutdown.

.3 AUTOMATIC SMOKE DETECTION SHUTOFF:

.1 Upon signal of alarm at a given duct smoke detector, de-energize associated supply fan and associated return or exhaust fans. Prevent fans from restarting until smoke detector has been reset.
.2 Following reset signal, provide adjustable time delay (30 to 120 seconds) before responding to another alarm signal to allow smoke to clear
.3 Initiate a Smoke Detected Shutoff alarm at the BAS HMI.
.4 Provide a dry contact with specific associated equipment identification for Smoke Alarm annunciation. Wiring from this dry contact to the Fire Alarm system is work of Section 13850, Fire Detection and Alarm.
.5 Coordinate with work of Division 16, Electrical.

.4 MOTOR START/STOP CONTROL:

.1 Provide single contact closure for START/STOP to each motor starter.
.2 Contact shall be closed to START motor.
.3 Contact shall be opened to STOP motor.
.4 Provide terminal contacts for connection by Division 16, Electrical.
.5 Hardwire ON and OFF poles of manual ON/OFF and HAND/OFF/COMPUTER switches directly to terminal contacts, so that malfunction of microprocessor hardware does not prevent manual on and off override.
.6 Coordinate with work of Division 16, Electrical.

.5 EQUIPMENT FAILURE ALARM:

.1 Work of Division 16, Electrical, includes provision of starter ON/OFF status signal to BAS for each motor controlled.
.2 For controlled motors, initiate Equipment Failure Alarm at the BAS HMI when motor is commanded to START and starter ON/OFF status indicates it is OFF.

.3 In addition, provide a differential pressure switch for each piece of air-moving equipment to determine actual flow failure. On lack of pressure differential, initiate Equipment Failure Alarm at the BAS HMI.

.6 **LEAD/LAG UNIT CONTROL (HYDRONIC SYSTEM CIRCULATING PUMPS):**

.1 Operate designated units in lead/lag arrangement. Automatically alternate status on weekly basis based on run time totalization.
.2 Upon indication of lead unit failure as described above, lock out the lead unit, reassign the lag unit to replace it, and initiate Failure Alarm at the BAS HMI with specific equipment identification.
.3 When both units have been off for more than two (2) weeks (adjustable) due to lack of demand, the BAS shall initiate exercise sequence to ensure that each unit is exercised for 5 minutes (adjustable) every two weeks (adjustable).

.7 **LOW TEMPERATURE SHUTDOWN:**

.1 Upon a signal from Mixed-air or Discharge-air Temperature sensor that temperature is below Low-Temperature-Limit set-point of 3°C (adjustable), de-energize the system, close outside air damper, open return air damper (if there is one), close exhaust air damper (if there is one), and initiate Low-Temperature-Shutdown Alarm at the BAS HMI.
.2 Remain shut down until manually reset or until the temperature sensor detects temperature above 12 °C.

.8 **HIGH TEMPERATURE LIMIT SHUTDOWN:**

.1 Upon a signal from Discharge-air Temperature sensor that the temperature is above High-Temperature-Limit set-point of 70°C (adjustable), de-energize the system and its associated exhaust fan, and initiate Low-Temperature-Shutdown Alarm at the BAS HMI.
.2 Remain shut down until manually reset or until the temperature sensor detects temperature below 30°C (adjustable)

.9 **HIGH HUMIDITY LIMIT SHUTDOWN:**

.1 Upon a signal from Discharge-air Humidity sensor that the relative humidity is above High-Humidity-Limit set-point of 80 percent (adjustable), de-energize the system and its associated exhaust fan, and initiate High-Humidity-Shutdown Alarm at the BAS HMI.
.2 Remain shut down until manually reset.

.10 **TWO-SPEED FAN CONTROL:**

.1 Provide adjustable time delay before engaging low speed when changing speed from high to low to allow fan to coast to lower rpm.
.2 Field adjust to time necessary for fan to slow from high speed down to halfway point between slow speed and stop.

.11 **PLC / PLANT SCADA INTERFACES:**

TYPICAL CONTROL SEQUENCES

.1 Provide a Networked DDC controller (HCP-H030) located in the Electrical Room No. 2 for the purpose of interfacing with Plant SCADA system.
.2 The controller shall have adequate capacity to include at least all the interfacing points as indicated on the schematic diagrams and described in the system sequence of operation.
.3 A system General Alarm shall be in the form of digital output, with specific system identification, to Plant SCADA system when any one or more alarm conditions exists within a system.
.4 Room temperature monitoring output to Plant SCADA shall be in the form of 4 to 20 mA analog output signal.

.12 **CHANGE FILTER ALARM:**

.1 Unless otherwise indicated, sense filter pressure drop for each filter bank by means of differential pressure switch that closes electrical contact when filter pressure differential exceeds adjustable set-point.
.2 Initiate the corresponding Filter Change alarm condition at the BAS HMI.

.13 **WINTER / SUMMER FILTER CHANGE ALARMS AND MONITORING:**

.1 Where Winter and Summer filter banks are indicated on the control schematic, sense filter pressure drop for each filter bank by means of differential pressure sensor across each filter bank.
.2 When the pressure differential across any filter is above 250 Pa (adjustable), initiate the corresponding Filter Change alarm condition at the BAS HMI
.3 When the pressure differential is less than 60 Pa (adjustable) for both filter banks, which indicates that the filters may be missing, initiate the corresponding Filter Missing alarm at the BAS HMI
.4 When the pressure differential is more than 80 Pa (adjustable) for both filter banks, which indicates that one of the filters should be removed, initiate the corresponding Filter Remove alarm at the BAS HMI.

.14 **UNIT HEATER (EUH AND GUH) CONTROL:**

.1 Furnish separate ON/OFF/AUTO manual subbase selector switch with each room thermostat for each heater.
.2 Room thermostat, through AUTO position of subbase switch, shall energize fan and burners to maintain space temperature indicated.
.3 On shutdown, fan shall continue to operate until heat exchanger discharge temperature drops below 45 ^{o}C, as determined by heat dissipation thermostat located at heat exchanger discharge side.
.4 In ON position, fan shall operate continuously and thermostat shall cycle burners.

.15 **STANDBY POWER MODE:**

.1 Upon receiving a digital signal identified as YY-H080A “Water Treatment Plant in Standby Power Mode – HVAC Shutdown Command” from Plant PLC, the BAS shall initiate the Standby Power Mode as follows:
.2 Initially, the BAS shall initiate system shutdown command for all systems within its domain.

.3 Within 30 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation for the first group of systems, which initially include the follow:
  .1 MAU-H021, EF-H023, Ozone Generator Room Emergency System
  .2 MAU-H032, EF-H038, Peroxide Storage and Feed System
  .3 MAU-H033, EF-H039, SBS Storage and Feed System
  .4 HRU-H022, EF-H024, EF-H025, Ozone Generator Room System
  .5 HRU-H-34, Maintenance Workshop System

.4 Within 60 seconds (adjustable) immediately after YY-H080A has been received, the BAS shall resume normal operation of the second group of systems which initially include the following:
  .1 MAU-H001, EF-H002, EF-H003, EF-H004, EF-H005. Filter Gallery System
  .2 MAU-H011, EF-H013, Pilot Plant Room System
  .3 MAU-H051, EF-H052, EF-H053, DAF Process Areas System

.5 Within 90 seconds (adjustable) immediately after YY-H080A has bee received, the BAS shall resume normal operation of the third group of systems which initially include the following:
  .1 The entire Heat Pump Condenser Water System, which includes but not limited to the system major components:
    .1 HWP-H007 and HWP-H008, Cooling Water Circulating Pumps
    .2 HWP-H016 and HWP-H017, Condenser Water Circulating Pumps
  .2 AHU-H035, Electrical Room No. 2 System
  .3 AHU-H061, RW Pump Room System
  .4 AHU-H062, Electrical Room No. 2 System
  .5 HP-H046, Back-up Server Room System
  .6 HP-H070, Server Room System
  .7 HP-H077, Control Room System.
  .8 HP-H097, Elevator Machine Room System.
  .9 EF-H015, Mechanical Room No.2 Heat Relief System
  .10 EF-H065, Fire Pump Room Heat Relief System.

.6 The programming of this sequence shall include functionalities that provide a means of adding and/or removing any system to and/or from the groups above through the HMI. These functionalities shall apply user-friendly operations such as drag-and-drop for the purpose of adding or removing systems.

.7 The programming of this sequence shall also take into consideration the components within each system, such that if a system is to be added or removed from a group, all components within the system must be included.

.16 **PRESET OCCUPIED SCHEDULE:**

.1 The BAS shall maintain the Preset Occupied Schedule for the purpose of resetting space temperature set points and reducing ventilation rates during unoccupied periods.

.2 Initially, the Preset Occupied Schedule shall be as follows:
  .1 Monday through Friday: 00:01 to 05:59 UNOCCUPIED
  .2 Monday through Friday: 06:00 to 18:00 OCCUPIED
  .3 Monday through Friday: 18:01 to 24:00 UNOCCUPIED
  .4 Saturday, Sunday and Holidays: UNOCCUPIED.

TYPICAL CONTROL SEQUENCES

.3 The Preset Occupied Schedule shall be easily edited to suite the actual of operating schedule of the Plant, which will be defined at a later day. Refer to specification Section 15902, Microprocessor Control Components for additional software editing capability requirements.

MAU-H001, EF-H002, EF-H003, EF-H004
FILTER GALLERIES
HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heating and ventilation for the Filtration Block, which includes the Filter Gallery, Filter Piping Gallery and Effluent Gate Room.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H001), a transfer fan serving the Effluent Gate Room (EF-H003), a transfer fan serving the Filter Piping Gallery (EF-H002) and an exhaust fan serving the Filter Gallery (EF-H004).

.2 The MAU-H001 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section
.6 Final Filter section, and
.7 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H002, EF-H003 and EF-H004 shall be controlled by BAS. Control wiring between EF-H004 and its motorized damper MD-H004A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

MAU-H001, EF-H002, EF-H003, EF-H004
FILTER GALLERIES
HEATING AND VENTILATION SYSTEM

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H001 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H002, EF-H003 and EF-H004 through their respective local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 EF-H002 is energized
.2 EF-H003 is energized
.3 MD-H004A open
.4 EF-H004 is energized, interlocked with MD-H004A

.7 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H002 is de-energized
.2 EF-H003 is de-energized
.3 EF-H004 is de-energized
.4 MD-H004A closed

.8 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

MAU-H001, EF-H002, EF-H003, EF-H004
FILTER GALLERIES
HEATING AND VENTILATION SYSTEM

.1 This system shall operate intermittently as described below and subject to alarms conditions.

.2 The BAS monitors the space temperature in the Filter Gallery (T-H001A), Filter Piping Gallery (T-H001B) and Effluent Gate Room (T-H001C) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H001A, T-H001B and T-H001C at minimum 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H001A, T-H001B and T-H001C at minimum 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 As a measure of energy conservation, the BAS cycles the operation of this system based on a regular basis. Initially, the system shall operate for 1 hour (adjustable) and de-energized for 15 minutes (adjustable). This sequence shall be delayed if any of the room sensor indicates temperature below the required set-point. In order to maintain proper building pressure distribution, the following system start/stop sequences shall be followed:

.1 Start Sequence:
.1 Start command for EF-H004
.2 Allow 30 seconds (adjustable), Start command for MAU-H001
.3 Allow 30 seconds (adjustable), Start command for EF-H002 and EF-H003 simultaneously.

.2 Stop Sequence:
.1 Stop command for MAU-H001
.2 After MAU-H001 has been proven stop, via system flow switch FS, Stop command for EF-H002, EF-H003 and EF-H004 simultaneously.

.6 During the off periods of the energy conservation cycle, if any of the room sensor senses temperature lower than set point, the BAS shall discontinue the energy conservation cycle and resume normal operation

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 The BAS monitors the pressure differential switch at the Final Filter and initiates alarm accordingly following the Change Filter Alarm sequences.

.3 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

MAU-H001, EF-H002, EF-H003, EF-H004
FILTER GALLERIES
HEATING AND VENTILATION SYSTEM

.4 When BAS detects no airflow (FS) signal while MAU-H001 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure alarms sequence shall be initiated.

.5 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.6 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.7 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.8 When FS-H002A detects no airflow while EF-H002 shall be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarms sequence shall be initiated.

.9 When SM-H002B detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.10 While the local HOC switch of EF-H002 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.11 When FS-H003A detects no airflow while EF-H003 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarms sequence shall be initiated.

.12 While the local HOC switch of EF-H003 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.13 When FS-H004B detects no airflow while EF-H004 shall be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarms sequence shall be initiated.

.14 When SM-H004C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.15 While the local HOC switch of EF-H004 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H011, EF-H013 PILOT PLANT ROOM HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide continuous heating and ventilation for the Pilot Plant Room.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H011) and an interlocking exhaust fan (EF-H013), both operating continuously to provide continuous ventilation for the Pilot Plant.

.2 The MAU-H011 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section
.6 Final Filter section, and
.7 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H013 shall be controlled by BAS. Control wiring between EF-H013 and its motorized damper MD-H013A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H011 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H013 through the local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 MD-H013A open
.2 EF-H013 is energized, interlocked with MD-H013A

.7 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H013 is de-energized
.2 MD-H013A closed

.8 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 MD-H013A open
.2 EF-H013 is energized, interlocked with MD-H013A

.9 When the switch is placed in the 'Computer' position, EF-H013 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate continuously, subject to alarm conditions.

.2 The BAS monitors the space temperature in the Pilot Plant Room (T-H011A) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H011A at 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H011A at 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 The BAS monitors the pressure differential switch at the Final filter and initiates alarm accordingly following the Change Filter Alarm sequences.

.3 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.4 When BAS detects no airflow (FS) signal while MAU-H011 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.5 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.6 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.7 While the factory-mounted local HOC switch is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.8 When FS-H013B detects no airflow while EF-H013 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.9 When SM-H013C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.10 While the local HOC switch of EF-H013 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H012, EF-H014 WASH-WATER RECOVERY GALLERY HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heating and ventilation for the Wash-Water Recovery Gallery.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H012) and an interlocking exhaust fan (EF-H014), both operating continuously to provide continuous ventilation for the Pilot Plant.

.2 The MAU-H012 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H014 shall be controlled by BAS. Control wiring between EF-H014 and its motorized damper MD-H014A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H012 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

MAU-H012, EF-H014 WASH-WATER RECOVERY GALLERY HEATING AND VENTILATION SYSTEM

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H014 through the local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 MD-H014A open
.2 EF-H014 is energized, interlocked with MD-H014A

.7 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H014 is de-energized
.2 MD-H014A closed

.8 When the switch is placed in the 'Computer' position, EF-H014 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate intermittently as described below and subject to alarm conditions.

.2 The BAS monitors the space temperature in the Wash-Water Recovery Gallery (T-H012A) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H012A at 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H012A at 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 As a measure of energy conservation, the BAS cycles the operation of this system on a regular basis. Initially, the system shall operate for 1 hour (adjustable) and is then de-energized for 15 minutes (adjustable). This sequence shall be delayed if any of the room sensor indicates temperature below the required set-point. In order to maintain proper building pressure distribution, the following system start/stop sequences shall be followed

.1 Start Sequence:

.1 Start command for EF-H014
.2 Allow 30 seconds (adjustable), Start command for MAU-H012

.2 Stop Sequence:

.1 Stop command for MAU-H001
.2 After MAU-H001 has been proven stop, via system flow switch FS, Stop command for EF-H014.

.6 During the off periods of the energy conservation cycle, if T-H012A senses temperature lower than set point, the BAS shall discontinue the cycle and resume normal operation

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while MAU-H012 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.6 While the factory-mounted local HOC switch is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H012, EF-H014 WASH-WATER RECOVERY GALLERY HEATING AND VENTILATION SYSTEM

.7 When T-H012A detects room temperature below 3 ^{o}C (adjustable) a Low Room Temperature alarm shall be annunciated

.8 When FS-H014B detects no airflow while EF-H014 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.9 When SM-H014C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.10 While the local HOC switch of EF-H014 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H021, EF-H023 OZONE GENERATOR ROOM EMERGENCY VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide emergency ventilation for the Ozone Generator Room.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H021) and an exhaust fan (EF-H023).

.2 The MAU-H021 shall include the following major components:

.1 Outside air damper (spring open energized to close)
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H023 shall be controlled by BAS. Control wiring between EF-H023 and its motorized damper MD-H023A (spring open, energized to close) shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H021 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 2 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H023 through the local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 MD-H023A open
.2 EF-H023 is energized, interlocked with MD-H023A

.7 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H023 is de-energized
.2 MD-H023A closed

.8 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 The BAS monitors the High Ozone Concentration signal from the Plant SCADA to determine the operating status of this ventilation system.

.2 Upon a signal from Plant SCADA system indicating that High Ozone Concentration condition exists, BAS shall command MAU-H021 and EF-H023 to start simultaneously.

.3 Once the system has been started, BAS shall keep the system operating continuously until the High Ozone Concentration signal has been de-energized by Plant SCADA system, at which time BAS shall keep the system operating for an additional 30 seconds (adjustable) then de-energize the system.

.4 As a preventive maintenance exercise, BAS shall command the system to start at least once every 7 days (adjustable) during unoccupied period, based on the preset schedule. The system shall be operating for 10 minutes (adjustable) during each excerise. Any alarms logged during this exercise period shall be indicated at the HMI with emphasis on urgent priority maintenance tasks.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI with **emphasis as urgent priority maintenance tasks**:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When BAS detects no airflow (FS) signal while MAU-H021 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.3 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.4 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.5 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.6 When FS-H023B detects no airflow while EF-H023 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.7 When SM-H023C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.8 While the local HOC switch of EF-H023 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H031, EF-H037 POLYMER FEED & STORAGE AREA HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide continuous heating and ventilation for the Polymer Feed and Storage area, which includes the Polymer Storage Room, Polymer Preparation and Feed Room and the Receiving Bay.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H031) and an interlocking exhaust fan (EF-H037), both operating continuously to provide continuous ventilation for the Polymer Feed and Storage Area.

.2 The MAU-H031 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H037 shall be controlled by BAS. Control wiring between EF-H037 and its motorized damper MD-H037A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H031 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H037 through the local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 MD-H037A open
.2 EF-H037 is energized, interlocked with MD-H037A

.7 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H037 is de-energized
.2 MD-H037A closed

.8 When the switch is placed in the 'Computer' position, EF-H037 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate continuously, subject to alarm conditions.

.2 The BAS monitors the space temperature in the Polymer Preparation and Feed Room (T-H031A), Receiving Bay (T-H031B) and Polymer Storage Room (T-H031C) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H031A, T-H031B and T-H031C at minimum 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H031A, T-H031B and T-H031C at minimum 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiate alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while MAU-H031 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.6 While the factory-mounted local HOC switch is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.7 When FS-H037B detects no airflow while EF-H037 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.8 When SM-H037C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.9 While the local HOC switch of EF-H037 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H032, EF-H038 PEROXIDE FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide continuous heating and ventilation for the Peroxide Feed and Storage Room. When additional ventilation is required, the system is also able to provide ventilation at double normal ventilation rate upon activation of a manual switch.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H032) and an interlocking exhaust fan (EF-H038), both operating continuously to provide continuous ventilation for the Peroxide Feed and Storage Room.

.2 The MAU-H032 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section (2 speed)
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H038 shall be controlled by BAS. Control wiring between EF-H038 and its motorized damper MD-H038A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H032 through the local factory-mounted Slow-Off-Fast-Computer (SOFC) switch.

MAU-H032, EF-H038 PEROXIDE FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.2 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in low speed, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in high speed, interlocked with outside air damper
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.5 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.6 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H038 through the local Slow-Off-Fast-Computer (SOFC) switch provided by Division 16.

.7 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 MD-H038A open
.2 EF-H038 is energized in low speed, interlocked with MD-H038A

.8 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H038 is de-energized
.2 MD-H038A closed

.9 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 MD-H038A open
.2 EF-H038 is energized in high speed, interlocked with MD-H038A

.10 When the switch is placed in the 'Computer' position, EF-H038 operation shall follow the sequences described in the Sequence of Operation section. A relay

contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION**

.1 This system shall operate continuously, subject to alarm conditions.

.2 The BAS monitors the space temperature in the Peroxide Feed and Storage Room (T-H032A) to determine the optimal operating condition of the heating and ventilation system.

.3 The system ventilation rate is controlled by the Ventilation Mode switch (SW-H032B), located immediately outside the Peroxide Feed and Storage Room.

.4 When SW-H032B is placed in the 'Hi" position, MAU-H032 and EF-H038 are energized on high speed.

.5 When SW-H032B is placed in the 'Lo" position, MAU-H032 and EF-H038 are energized on low speed.

.6 During occupied periods, based on a preset schedule, the BAS shall maintain T-H032A at 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller

.7 During unoccupied periods, the BAS shall maintain T-H032A at 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiate alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while MAU-H032 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.6 While the factory-mounted local SOFC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H032, EF-H038 PEROXIDE FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.7 When T-H032A detects room temperature above 35 ^{o}C (adjustable) a High Room Temperature alarm shall be annunciated.

.8 When FS-H038B detects no airflow while EF-H038 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.9 When SM-H038C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.10 While the local SOFC switch of EF-H038 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H033, EF-H039 SBS FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide continuous heating and ventilation for the SBS Feed and Storage Room. When additional ventilation is required, the system is also able to provide ventilation at double normal ventilation rate upon activation of a manual switch.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H033) and an interlocking exhaust fan (EF-H039), both operating continuously to provide continuous ventilation for the SBS Feed and Storage Room.

.2 The MAU-H033 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section (2 speed)
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H039 shall be controlled by BAS. Control wiring between EF-H039 and its motorized damper MD-H039A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H033 through the local factory-mounted Slow-Off-Fast-Computer (SOFC) switch.

MAU-H033, EF-H039 SBS FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.2 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in low speed, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in high speed, interlocked with outside air damper
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.5 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.6 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H039 through the local Slow-Off-Fast-Computer (SOFC) switch provided by Division 16.

.7 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 MD-H039A open
.2 EF-H039 is energized in low speed, interlocked with MD-H039A

.8 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H039 is de-energized
.2 MD-H039A closed

.9 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 MD-H039A open
.2 EF-H039 is energized in high speed, interlocked with MD-H039A

.10 When the switch is placed in the 'Computer' position, EF-H039 operation shall follow the sequences described in the Sequence of Operation section. A relay

contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION**

.1 This system shall operate continuously, subject to alarm conditions.

.2 The BAS monitors the space temperature in the SBS Feed and Storage Room (T-H033A) to determine the optimal operating condition of the heating and ventilation system.

.3 The system ventilation rate is controlled by the Ventilation Mode switch (SW-H033B), located immediately outside the SBS Feed and Storage Room.

.4 When SW-H033B is placed in the 'Hi" position, MAU-H033 and EF-H039 are energized on high speed.

.5 When SW-H033B is placed in the 'Lo" position, MAU-H033 and EF-H039 are energized on low speed.

.6 During occupied periods, based on a preset schedule, the BAS shall maintain T-H031A at 20 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.7 During unoccupied periods, the BAS shall maintain T-H033A at 20 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller..

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiate alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while MAU-H033 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.6 While the factory-mounted local SOFC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H033, EF-H039 SBS FEED & STORAGE ROOM HEATING AND VENTILATION SYSTEM

.7 When T-H033A detects room temperature below 12 ^{o}C (adjustable) a Low Room Temperature alarm shall be annunciated

.8 When FS-H039B detects no airflow while EF-H039 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.9 When SM-H039C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.10 While the local SOFC switch of EF-H039 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

MAU-H051, EF-H052, EF-H053 DAF PROCESS GALLERY HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heating and ventilation for the DAF Process area, which includes the DAF Process Gallery, DAF Pump Gallery and DAF Influent Gallery.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a make-up air unit (MAU-H051), a transfer fan serving the DAF Pump Gallery (EF-H053) and an exhaust fan serving the DAF Process Gallery (EF-H052).

.2 The MAU-H051 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 Supply Fan section
.4 Natural Gas Burner
.5 Winter Filter section, and
.6 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan and the modulation of the gas burner.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.7 The operation of EF-H052 and EF-H053 shall be controlled by BAS. Control wiring between EF-H052 and its motorized damper MD-H052A shall be provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control MAU-H051 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized, interlocked with outside air damper.
.3 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H052 and EF-H053 through their respective local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 EF-H053 is energized
.2 MD-H052A open
.3 EF-H052 is energized, interlocked with MD-H052A

.7 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H053 is de-energized
.2 EF-H052 is de-energized
.3 MD-H052A closed

.8 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate intermittently as described below and subject to alarm conditions.

.2 The BAS monitors the space temperature in the DAF Process Gallery (T-H051A), DAF Pump Gallery (T-H051B) and DAF Influent Gallery (T-H051C) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H051A, T-H051B and T-H051C at minimum 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H051A, T-H051B and T-H051C at minimum 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 In providing the supply air temperature set point reset to the factory mounted controller, the BAS shall ensure that the temperature senses by T-H051B will not exceed 30 degree C (adjustable). This requirement shall override the minimum room temperature requirement described above.

.6 As a measure of energy conservation, the BAS cycles the operation of this system based on a regular basis. Initially, the system shall operate for 1 hour (adjustable) and is then de-energized for 15 minutes (adjustable). This sequence shall be delayed if any of the room sensor indicates temperature below the required set-point or T0H051B senses temperature above 30 ^{o}C (adjustable). In order to maintain proper building pressure distribution, the following system start/stop sequences shall be followed:

.1 Start Sequence:
- .1 Start command for EF-H052
- .2 Allow 30 seconds (adjustable), Start command for MAU-H051
- .3 Allow 30 seconds (adjustable), Start command for EF-H002 and EF-H003 simultaneously.

.2 Stop Sequence:
- .1 Stop command for MAU-H051
- .2 After MAU-H051 has been proven stop, via system flow switch FS, Stop command for EF-H002, EF-H003 and EF-H052 simultaneously.

.7 During the off periods of the energy conservation cycle, if any of the room sensors senses temperature lower than set point or if T-H051B senses temperature above 30 degree C (adjustable), the BAS shall discontinue the cycle and resume normal operation.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while MAU-H051 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

MAU-H051, EF-H052, EF-H053 DAF PROCESS GALLERY HEATING AND VENTILATION SYSTEM

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.6 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.7 When FS-H052B detects no airflow while EF-H052 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.8 When SM-H052C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.9 While the local HOC switch of EF-H052 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.10 When FS-H053B detects no airflow while EF-H053 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.11 When SM-H053C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.12 While the local HOC switch of EF-H053 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

AHU-H035 ELECTRICAL ROOM NO. 2
VENTILATION AND COOLING SYSTEM

.1 **OBJECTIVES:**

.1 The primary objective of this system is to control the room temperature of the Electrical Room No.1. As a measure to conserve energy, this system also utilizes the Economizer Mode to provide heat relief ventilation whenever outdoor condition is favorable.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an Air handling unit (AHU-H035) and a gravity relief vent complete with a counter-balanced back-draft damper.

.2 The AHU-H035 shall include the following major components:

.1 Mixing Plenum complete with modulating outside-air and return air dampers
.2 Air Filter Section
.3 Supply Fan
.4 Water-cooled DX Cooling section, and
.5 Factory-mounted Controller

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, return air damper, the supply fan, and the staging of DX Cooling compressors.

.4 When Economizer Mode is enabled by the BAS, the Factory-mounted controller shall modulate the return-air motorized damper and outside-air motorized damper to maintain mixed air temperature at 15 ^{o}C.

.5 The Factory-mounted controller shall stage the DX Cooling compressors to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 15 ^{o}C, unless reset by BAS.

.6 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.7 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Supply fan is energized
.2 Outside air damper fully closed.
.3 Return air damper fully open
.4 DX-Cooling compressors stage to maintain supply air temperature set point at 15 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper fully closed
.3 Return air damper fully open
.4 DX-Cooling compressors de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted control system shall send a digital output to the BMS to indicate that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 The BAS monitors the Electrical Room No.2 temperature (T-H035A), and outdoor air temperature to evaluate the optimal operating condition of the AHU-H035.

.2 When T-H035A detects temperature at or below 24 ^{o}C (adjustable), AHU-H035 shall be de-energized, following the system shutdown sequence

.3 When T-H035A detects temperatures above 24 ^{o}C (adjustable) AHU-H035 shall be energized, the BAS shall provide Supply Air temperature set-point reset to Factory-mounted controller based on the following linear schedule:

.1 T-H035A = 24C, SA Temp Set-point = 24C (adjustable)
.2 T-H035A = 40C, SA Temp Set-point = 15C (adjustable)

.4 While T-H035A detects temperature above 24 ^{o}C, the BAS shall enable Economizer Mode when T-H035A - OA Temp > 5 ^{o}C.

.5 ALARMS:

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential switch at the Final Filter and initiates alarm accordingly following the Change Filter Alarm sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

AHU-H035 ELECTRICAL ROOM NO. 2
VENTILATION AND COOLING SYSTEM

.3 When BAS detects no airflow (FS) signal while AHU-H035 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

AHU-H061 RAW WATER PUMP ROOM
COOLING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The primary objective of this system is to control the room temperature of the RW Pump Room. As a measure to conserve energy, this system also utilizes the heat generated by the RW pumping equipment to the provide heating for the Valve Access Chamber as well as for the Heat Pump Condenser Water System.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists and air handling unit AHU-H061 and three gravity relief roof vents complete with counter-balanced back-draft dampers

.2 The AHU-H061 which shall include the following major components:

.1 Mixing Plenum complete with modulating outside-air and return air dampers
.2 Filter Section
.3 Supply Fan
.4 Water-cooled DX Cooling section, and
.5 Factory-mounted Controller

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, return air damper, the supply fan, and the staging of DX Cooling compressors.

.4 When Economizer Mode is enabled by the BAS, the Factory-mounted controller shall modulate the return-air motorized damper and outside-air motorized damper to maintain mixed air temperature at 15 ^{o}C.

.5 When Cooling Mode is enabled by the BAS, the Factory-mounted controller shall stage the DX Cooling compressors to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 15 ^{o}C, unless reset by BAS

.6 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.7 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Supply fan is energized
.2 Outside-air damper fully closed
.3 Return-air damper fully open
.4 DX-Cooling compressors stage to maintain supply air temperature at 15C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside-air damper fully closed
.3 Return-air damper fully open
.4 DX-Cooling compressors de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted control system shall send a digital output to the BAS to indicate that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 The BAS monitors the RW Pump Room temperature (T-H061A), the Valve Access Chamber temperature (T-H061B), outdoor air temperature and the Heat Pump Condenser Water system temperature to evaluate the optimal operating condition of the air handling system.

.2 When T-H061A detects temperature below 20 ^{o}C (adjustable), AHU-H061 shall be de-energized

.3 When T-H061A detects temperatures between 20 and 25 ^{o}C (adjustable) and T-H061B detects temperature below 15 ^{o}C (adjustable), AHU-H061 is energized with the Economizer Mode and Cooling Mode being disabled. This will result in the AHU-H061 re-circulating warm air from the RW Pump room to the cooler Valve Access Chamber.

.4 When T-H061A detects temperatures above 25 ^{o}C (adjustable) AHU-H061 shall be energized, Cooling Mode is enabled and Supply Air temperature set-point shall be based on the following linear schedule:

.1 T-H061A = 25C, SA Temp Set-point = 25C (adjustable)
.2 T-H061A = 40C, SA Temp Set-point = 15C (adjustable)

.5 While T-H061A detects temperature above 25 ^{o}C, the Economizer Mode is enabled when the following conditions are met:

.1 T-H061A - OA Temp > 5 ^{o}C, and
.2 HP Condenser Water Temp > 13 ^{o}C (adjustable)

.5 ALARMS:

AHU-H061 RAW WATER PUMP ROOM
COOLING AND VENTILATION SYSTEM

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential switch at the Final Filter and initiates alarm accordingly following the Change Filter Alarm sequences.

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while AHU-H061 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

AHU-H062 ELECTRICAL ROOM NO. 1
VENTILATION AND COOLING SYSTEM

.1 OBJECTIVES:

.1 The primary objective of this system is to control the room temperature of the Electrical Room No.1. As a measure to conserve energy, this system also utilizes the Economizer Mode to provide heat relief ventilation whenever outdoor condition is favorable.

.2 SYSTEM DESCRIPTION:

.1 This system consists of an Air handling unit (AHU-H062) and a gravity relief vent complete with a counter-balanced back-draft damper.

.2 The AHU-H062 shall include the following major components:

.1 Mixing Plenum complete with modulating outside-air and return air dampers
.2 Air Filter Section
.3 Supply Fan
.4 Water-cooled DX Cooling section, and
.5 Factory-mounted Controller

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, return air damper, the supply fan, and the staging of DX Cooling compressors.

.4 When Economizer Mode is enabled by the BAS, the Factory-mounted controller shall modulate the return-air motorized damper and outside-air motorized damper to maintain mixed air temperature at 15 ^{o}C.

.5 The Factory-mounted controller shall stage the DX Cooling compressors to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 15 ^{o}C, unless reset by BAS.

.6 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.7 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.3 LOCAL OPERATOR INTERFACE:

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Supply fan is energized
.2 Outside air damper fully closed.
.3 Return air damper fully open
.4 DX-Cooling compressors stage to maintain supply air temperature set point at 15 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper fully closed
.3 Return air damper fully open
.4 DX-Cooling compressors de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted control system shall send a digital output to the BMS to indicate that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 The BAS monitors the Electrical Room No.2 temperature (T-H062A), and outdoor air temperature to evaluate the optimal operating condition of the AHU-H062.

.2 When T-H062A detects temperature at or below 24 ^{o}C (adjustable), AHU-H062 shall be de-energized, following the system shutdown sequence.

.3 When T-H062A detects temperatures above 24 ^{o}C (adjustable) AHU-H062 shall be energized, the BAS shall provide Supply Air temperature set-point reset to Factory-mounted controller based on the following linear schedule:

.1 T-H062A = 24C, SA Temp Set-point = 24C (adjustable)

.2 T-H062A = 40C, SA Temp Set-point = 15C (adjustable)

.4 While T-H062A detects temperature above 24 ^{o}C, the BAS shall enable Economizer Mode when T-H062A - OA Temp > 5 ^{o}C.

.5 ALARMS:

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential switch at the Final Filter and initiates alarm accordingly following the Change Filter Alarm sequences.

AHU-H062 ELECTRICAL ROOM NO. 1
VENTILATION AND COOLING SYSTEM

.2 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.3 When BAS detects no airflow (FS) signal while AHU-H062 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.5 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

AHU-071, EF-H075, EF-H076 ADMINISTRATION AREA VENTILATION AIR SUPPLY

.1 **OBJECTIVES:**

.1 The main objective of this system is to provide treated tempered ventilation air to the spaces within the Administration Area. This system also provides the outside air required to maintain the Administration Area under positive pressure with respect to the adjacent process areas.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an air handling unit AHU-H071, an exhaust fan serving the Third Administration Level (EF-H075), an exhaust fan serving the Second Administration Level (EF-H076), a recirculation air damper (MD-H071A) and an exhaust air damper (MD-H071B).

.2 The AHU-H071 shall include the following major components:

.1 Outside Air Damper
.2 Summer Filter section
.3 Supply Fan section (2-Speed)
.4 Natural Gas Fired Burner
.5 Winter Filter section
.6 Final Filter section
.7 Water-cooled DX Cooling Section
.8 Natural Gas Fired Steam Humidifier section, and
.9 Factory-mounted controller

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the supply fan, the modulation of the gas burner, the staging of DX Cooling compressors and the modulation of the steam humidifier.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at heating supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS

.5 The factory-mounted controller stages the DX Cooling compressors to maintain supply air temperature at cooling supply air temperature set-point. The default cooling supply air temperature set-point is 15 ^{o}C, unless reset by BAS

.6 The factory-mounted controller modulates the steam output of the humidifier to maintain supply air relative humidity set-point. The default supply air relative humidity set-point is 35%, unless reset by BAS

.7 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.8 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at

least all the control points indicated on the control schematic drawings and herein described.

.9 Each of the exhaust fan is equipped with a variable frequency drive (VFD). The BAS controls the operation of the exhaust fans EF-H075 and EF-H076 as well as the motorized dampers MD-H071A and MD-H071B.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control AHU-H071 through the local factory-mounted Slow-Off-Fast-Computer (SOFC) switch.

.2 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in low speed, interlocked with outside air damper
.3 Gas Burner modulates to maintain supply air temperature at 13 deg. C
.4 DX-Cooling compressors stage to maintain supply air temperature at 15C
.5 Steam Humidifier modulates to maintain supply air RH at 35%

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Outside air damper closed
.2 Supply fan is de-energized
.3 Gas Burner is de-energized
.4 DX-Cooling compressors are de-energized
.5 Steam Humidifier de-energized

.4 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 Outside air damper open
.2 Supply fan is energized in high speed, interlocked with outside air damper
.3 Gas Burner modulates to maintain supply air temperature at 13 deg. C
.4 DX-Cooling compressors stage to maintain supply air temperature at 15C
.5 Steam Humidifier modulates to maintain supply air RH at 35%

.5 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted control system shall send a digital output to the BMS indicating that the local switch is placed in the 'Computer' position.

.6 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H075, and EF-H076 through their respective local Hand-Off-Computer (HOC) switch provided by Division 16.

.7 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 EF-H075 is energized at full speed
.2 EF-H076 is energized at full speed

.8 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H075 is de-energized
.2 EF-H076 is de-energized

.9 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate continuously as described below and subject to alarm condition.

.2 During unoccupied periods, based on preset occupied schedule, the BAS energizes AHU-H071 on low speed and resets the cooling supply air temperature set-point to 26 ^{o}C (adjustable).

.3 During occupied period, the BMS energizes AHU-H071 on high speed and resets cooling supply air temperature set-point to 15 ^{o}C (adjustable), heating supply air temperature set-point to 13 ^{o}C (adjustable).

.4 Humidity Control: The BAS shall maintain H-H071C at 35% RH by providing supply air relative humidity set-point reset to the factory-mounted controller. The BAS shall limit the relative humidity set-point reset to ensure that the supply air relative humidity shall not exceed 80%.

.5 Carbon Dioxide Control: The BAS shall modulate MD-H071A and MD-H071B to maintain the CO2-H071D below 700 ppm in comparison with CO2-H071E

.6 Third Level Space Pressurization Control: The BAS shall modulate fan speed of EF-H075 to maintain PD-H075A at 25 Pa (adjustable) above adjacent DAF Process area.

.7 Second Level Space Pressurization Control: The BAS shall modulate fan speed of EF-H076 to maintain PD-H076A at 25 Pa (adjustable) above adjacent DAF Influent Gallery.

.8 During unoccupied periods, based on the preset occupied schedule, if any of the local zone occupied switches within the Administration area is activated, the BAS

shall operate the AHU-H071 as if occupied period is in effect. The duration of the unoccupied override is initially set at 4 hours (adjustable).

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiates alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 The BAS monitors the pressure differential switch at the Final filter and initiates alarm accordingly following the Change Filter Alarm sequences.

.3 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.4 When BAS detects no airflow (FS) signal while AHU-H071 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.5 When BAS detects smoke signal (SM), a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.6 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated

.7 When BAS detects the relative humidity (H) above 80%, a High Humidity Limit Shutdown alarm is logged and a High Humidity Limit Shutdown sequence shall be initiated

.8 While the factory-mounted local SOFC switch is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.9 When FS-H075B detects no airflow while EF-H075 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.10 When SM-H075C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.11 While the local HOC switch of EF-H075 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.12 When FS-H076B detects no airflow while EF-H076 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.13 When SM-H076C detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

AHU-071, EF-H075, EF-H076 ADMINISTRATION AREA VENTILATION AIR SUPPLY

.14 While the local HOC switch of EF-H076 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

HRU-H022, EF-H024, EF-H025 OZONE GENERATOR ROOM HEATING AND VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide continuous heating and ventilation for the Ozone Generation block, which includes the Ozone Generator Room and Access Corridors 2, 3 5 and 6. This system also contributes to the Emergency Ventilation System for the Ozone Generator Room.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of a heat recovery unit (HRU-H022), a transfer fan serving Access Corridors 2 and 5 (EF-H025) and a transfer fan serving Access Corridor 3 and 6 (EF-H024).

.2 The HRU-H022 shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 By-Pass Damper
.4 Heat Recovery Coil
.5 Supply Fan section
.6 Natural Gas Burner
.7 Winter Filter section
.8 Exhaust air Filter section
.9 Exhaust Fan section
.10 Exhaust air damper (spring open, energized to close), and
.11 Factory-mounted controller.

.3 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the modulation of the by-pass damper, the supply fan, the modulation of the gas burner the exhaust fan and the exhaust air damper.

.4 The factory-mounted controller modulates the by-pass damper to ensure that the exhaust air leaving the heat recovery coil is maintained above freezing temperature in order to prevent frosting on the supply side of the heat recovery coil. When outside entering the heat recovery coil reaches temperature above 13 ^{o}C, the bypass damper shall be fully open.

.5 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.6 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.7 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at

least all the control points indicated on the control schematic drawings and herein described.

.8 The BAS also controls the operation of transfer fans EF-H024 and EF-H025.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control HRU-H022 through the local factory-mounted Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 Outside air damper open
.2 By-pass damper open
.3 Exhaust air damper open
.4 Supply fan is energized, interlocked with outside air damper.
.5 Exhaust fan is energized, interlocked with exhaust air damper.
.6 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Exhaust fan is de-energized
.4 Exhaust air damper closed
.5 By-pass damper closed.
.6 Gas burner is de-energized

.4 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.5 Similarly, in addition to the interface available at the HMI, the Operator can also manually control EF-H024 and EF-025 through their respective local Hand-Off-Computer (HOC) switch provided by Division 16.

.6 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 EF-H024 is energized
.2 EF-H025 is energized

.7 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H024 is de-energized
.2 EF-H025 is de-energized

.8 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION

.1 This system shall operate continuously, subject to alarm conditions.

.2 The BAS monitors the High Ozone Concentration signal from the Plant SCADA, the space temperature in the Ozone Generator Room (T-H022A), Access Corridor No. 2 (T-H022B), Access Corridor No. 3 (T-H022C), Access Corridor No. 5 (T-H022D) and Access Corridor No. 6 (T-H022E) to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H022A, T-H022B, T-H022C, T-H022D and T-H022E at minimum 15 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H022A, T-H22B, T-H22C, T-H022D and T-H022E at 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 In providing the supply air temperature set-point reset to the factory mounted controller, the BAS shall ensure that the temperature senses by T-H022A will not exceed 30 degree C (adjustable). This requirement shall override the minimum room temperature requirement described above.

.6 Upon a signal from Plant SCADA system indicating that High Ozone Concentration condition exists, the BAS shall command the exhaust fan of HRU-H022 to be de-energized. Upon the High Ozone Concentration signal has been de-energized by Plant SCADA system, at which time BAS shall keep the exhaust fan system operating for an additional 30 seconds (adjustable)

.7 Once the High Ozone Concentration signal has been energized, the BAS shall keep the exhaust fan of HRU-H022 de-energized until the High Ozone Concentration signal has been de-energized by Plant SCADA system, at which time BAS shall keep the exhaust de-energized for an additional 30 seconds (adjustable, matching with the delay described in the Ozone Generator Room Emergency Ventilation system) then command the exhaust fan to start.

.8 As a preventive maintenance exercise for the Ozone Generator Room Emergency Ventilation system, the BAS shall de-energize the exhaust fan of HRU-H022 at least once every 7 days (adjustable, matching with the frequency and duration described in the Ozone Generator Room Emergency Ventilation system). Any alarms logged during this exercise period shall be indicated at the HMI with emphasis on urgent priority maintenance tasks

.5 ALARMS:

HRU-H022, EF-H024, EF-H025 OZONE GENERATOR ROOM HEATING AND VENTILATION SYSTEM

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiate alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 The BAS monitors the pressure differential switch at the exhaust filter and initiates alarm accordingly following the Change Filter Alarm sequences

.3 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.4 When BAS detects no airflow (FS) signal from the supply air stream while the supply fan of HRU-H022 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.5 When BAS detects no airflow (FS) signal from the exhaust air stream while the exhaust fan of HRU-H022 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated

.6 When BAS detects smoke signal (SM) from either supply or exhaust air stream, a corresponding Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.7 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.8 While the factory-mounted local HOC switch is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.9 When FS-H024A detects no airflow while EF-H024 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.10 When SM-H024B detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.11 While the local HOC switch of EF-H024 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

.12 When FS-H025A detects no airflow while EF-H025 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.13 While the local HOC switch of EF-H025 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated

HRU-H034 MAINTENANCE WORKSHOP AREA
HEATING AND VENTILATION SYSTEM

.1 Objectives:

.1 The objective of this system is to provide heating and ventilation for the Maintenance Workshop area, which includes the Instrument Workshop Mezzanine, the Backup Server Room and various spaces within the Maintenance Workshop Level.

.2 System Description:

.1 This system consists of a heat recovery unit (HRU-H034), which shall include the following major components:

.1 Outside air damper
.2 Summer Filter section
.3 By-Pass Damper
.4 Heat Recovery Coil
.5 Supply Fan section (2 speed)
.6 Natural Gas Burner
.7 Winter Filter section
.8 Exhaust air Filter section
.9 Exhaust Fan section (2 speed)
.10 Exhaust air damper, and
.11 Factory-mounted controller.

.2 The factory-mounted controller shall include all the control devices and interfaces with the BAS all the control points indicated on the control schematic drawings and herein described. This controller also controls the operation of the outside air damper, the modulation of the by-pass damper, the supply fan, the modulation of the gas burner the exhaust fan and the exhaust air damper.

.3 The factory-mounted controller modulates the by-pass damper to ensure that the exhaust air leaving the heat recovery coil is maintained above freezing temperature in order to prevent frosting on the supply side of the heat recovery coil. When outside entering the heat recovery coil reaches temperature above 13 ^{o}C, the by-pass damper shall be fully open.

.4 The factory-mounted controller modulates the gas burner to maintain supply air temperature at supply air temperature set-point. The default supply air temperature set-point is 13 ^{o}C, unless reset by BAS.

.5 The factory-mounted controller interfaces with the BAS through hard-wiring to a networked DDC Controller mounted within the allocated space inside the unit's control cabinet.

.6 The networked DDC Controller shall be supplied and installed by the HVAC Control Subcontractor. The controller shall have adequate capacity to include at least all the control points indicated on the control schematic drawings and herein described.

.3 Local Operator Interface:

HRU-H034 MAINTENANCE WORKSHOP AREA
HEATING AND VENTILATION SYSTEM

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control HRU-H034 through the local factory-mounted Slow-Off-Fast-Computer (SOFC) switch.

.2 When the switch is placed in the 'Slow' position, the following sequence shall take place:

.1 Outside air damper open
.2 By-pass damper open
.3 Exhaust air damper open
.4 Supply fan is energized low speed, interlocked with outside air damper.
.5 Exhaust fan is energized low speed, interlocked with exhaust air damper.
.6 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 Supply fan is de-energized
.2 Outside air damper closed
.3 Exhaust fan is de-energized
.4 Exhaust air damper closed
.5 By-pass damper closed.
.6 Gas burner is de-energized

.4 When the switch is placed in the 'Fast' position, the following sequence shall take place:

.1 Outside air damper open
.2 By-pass damper open
.3 Exhaust air damper open
.4 Supply fan is energized on high speed, interlocked with outside air damper.
.5 Exhaust fan is energized on high speed, interlocked with exhaust air damper.
.6 Gas burner modulates to maintain supply air temperature at 13 ^{o}C

.5 When the switch is placed in the 'Computer' position, the system shall follow the sequences described in the Sequence of Operation section. The factory-mounted controller shall send a digital signal to BAS indicating that the local switch is placed in the 'Computer' position.

.4 Sequence of Operation

.1 This system shall operate intermittently as described below and subject to alarm conditions.

.2 The BAS monitors the space temperature in the Mechanical Shop Area (T-H034A), the status of the Multi-gas detector in the Vehicle area, the status of the welding hood switch and the status of the occupied switches in the Back-up Server Room and the Instrument workshop Mezzanine to determine the optimal operating condition of the heating and ventilation system.

.3 During occupied periods, based on a preset schedule, the BAS shall maintain T-H034A at 22 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.4 During unoccupied periods, the BAS shall maintain T-H034A at 10 ^{o}C (adjustable) by providing supply air temperature set-point reset to the factory-mounted controller.

.5 As a measure of energy conservation, during unoccupied periods, the BAS cycles the operation of this system on a regular basis. Initially, the system shall operate for 1 hour (adjustable) and is then de-energized for 15 minutes (adjustable). This sequence shall be delayed if T-H034A indicates temperature below the required set-point.

.6 During the Off periods of the energy conservation cycle, if T-H034A senses temperature lower than set point, the BAS shall discontinue the cycle and resume normal operation.

.7 During the Off periods of the energy conservation cycle, if any of the occupied switch is activated, the BAS shall discontinue the cycle and resume normal operation.

.8 The BAS determines the fan speed of the supply and exhaust fans of HRU-H034 based on the Ventilation Mode status. When a High status is assigned for the Ventilation Mode, the fans are energized on high speed when operation is required. When a Low status is assigned for the Ventilation Mode, the fans are energized on low speed when operation is required.

.9 The status of the Ventilation Mode is assigned based on the status of the Multi-gas sensor (G-H034B) and the welding hood switch (SW-H034C). Normally the a Low status for Ventilation Mode is assigned. A High status for Ventilation Mode is assigned when any of the following condition exists:

.1 G-H034B detects carbon monoxide concentration level above 100 parts per millions parts of air.
.2 G-H034B detects nitrogen dioxide concentration level above 3 parts per millions parts of air.
.3 SW-H034C is placed in ON position.

.5 Alarms:

.1 The following system alarms are indicated at the HMI:

.1 The BAS monitors the pressure differential sensors at the Winter and Summer filters and initiate alarms accordingly following the Winter / Summer Filter Change Alarms and Monitoring sequences.

.2 The BAS monitors the pressure differential switch at the exhaust filter and initiates alarm accordingly following the Change Filter Alarm sequences

HRU-H034 MAINTENANCE WORKSHOP AREA
HEATING AND VENTILATION SYSTEM

.3 When the BAS detects the Low Limit signal (Fz), a Low Limit Shutdown Alarm is logged and a Low Temperature Shutdown sequence shall be initiated.

.4 When BAS detects no airflow (FS) signal from the supply air stream while the supply fan of HRU-H034 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.5 When BAS detects no airflow (FS) signal from the exhaust air stream while the exhaust fan of HRU-H034 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated

.6 When BAS detects smoke signal (SM) from either supply or exhaust air stream, a corresponding Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.7 When BAS detects the High Limit signal (TSH), a High Limit Shutdown alarm is logged and a High Limit Shutdown sequence shall be initiated.

.8 While the factory-mounted local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

.9 When G-H034B detects carbon monoxide concentration above 100 parts per millions parts of air, BAS shall log and annunciate this alarm.

.10 When G-H034B detects nitrogen dioxide concentration above 3 parts per millions parts of air, BAS shall log and annunciate this alarm.

WATER SOURCE HEAT PUMPS (WSHP)
HEATING & AIR-CONDITIONING CONTROLS

.1 **OBJECTIVES:**

.1 The objective of these systems is to provide comfort heating and air-conditioning for the spaces within the Administration Area and the Instrumentation Workshop Area.

.2 **SYSTEM DESCRIPTION:**

.1 This control sequence description is applicable for the following WSHP units:

.1 HP-H045 and HP-H046
.2 HP-H070, HP-H077 to HP-H099

.2 Each of these WSHP systems consists of a WSHP unit and an electronic programmable zone controller.

.3 Each WSHP unit shall include the following major components:

.1 Return air Filter rack
.2 DX Heat Pump Coil
.3 Heat-Pump compressor(s)
.4 Supply air fan, and
.5 Factory-mounted controller.

.4 The factory-mounted controller shall include all internal control devices to control the internal operation of the heat pump unit. This includes the operation of the Heat-Pump compressor, DX Reversing valve and the blower.

.5 The electronic zone controller shall be supplied and installed by the HVAC Control Subcontractor. This controller shall provide room temperature set-point to the factory-mounted controller and communicate with the BAS through Lon-Works protocol.

.3 **LOCAL OPERATOR INTERFACE:**

.1 Direct interface with the heat pump system is through the electronic zone controller, which shall include the following features:

.1 365-day programmable
.2 Zone temperature set-point adjustment
.3 Occupied Mode override
.4 Filter Change indicator
.5 Refer to specification Section 15901 - HVAC Controls, Field Components and Instrumentation for additional features of the Zone Controller.

.4 **SEQUENCE OF OPERATION**

.1 Temperature Control:

.1 The Zone Controller shall maintain zone temperature at set-points by sending heating or cooling signal to the Factory-mounted controller.

.2 The zone temperature set points shall be based on the occupied schedule programmed at the Zone Controller. Initially, the following temperature set point shall apply:

.1 Unoccupied Periods: Heating = 15C, Cooling = 28C

.2 Occupied Periods: Heating = 22C, Cooling = 24C

.2 Blower Control:

.1 During Occupied periods, the Zone Controller shall send signal to the Factory-mounted controller to keep the blower operating continuously.

.2 During Unoccupied periods, the Zone Controller shall send signal to the Factory-mounted controller to energize the blower only when heating or cooling is required

.3 Occupied Schedule

.1 Initially, the following Zone Controller programmed Occupied Schedule shall apply:

.1 Monday to Friday, 00:00 to 06:30, Unoccupied

.2 Monday to Friday, 06:30 to 18:00, Occupied

.3 Monday to Friday, 18:00 to 24:00, Unoccupied

.4 Weekends and Holidays, Unoccupied

.4 Interface with BAS

.1 Each Zone Controller shall communicate with the BAS the following control points:

.1 Current Space Temperature

.2 Occupied Status.

.3 Filter Change Status

.4 Unit failure alarm

.5 **ALARMS**

.1 The following alarms are indicated at the HMI for each WSHP unit:

.1 Unit Failure Alarm

.2 Filter Change Alarm

HWP-H007, HWP-H008, HWP-H016, HWP-H017
CONDENSER WATER SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide temperature controlled condenser water to all the equipment that utilize condenser water for heating and/or cooling purposes.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of two double-walled plate-and-frame heat exchangers (HX-H010A and HX-H010B), two gas-fired hot water boilers (B-H018 and B-H019) and a set of Condenser Water circulating pumps (HWP-H016 & HWP-H017) that circulate condenser water to all the condenser water utilizing equipment in the system.

.2 The HX-H010A and HX-H010B is the cooling source for the system and the B-H018 and B-H019 heat source for the system.

.3 Cooling water supply is delivered to HX-H010A and HX-H010B by a set of Cooling Water circulating pumps (HWP-H007 and HWP-H008). Cooling water is drawn from the Filtered Water Overflow chamber, circulated through the heat exchangers and discharge into the DAF Effluent Conduit.

.4 The circulating pumps have been designed with 100% redundancy. In 'Computer' mode, the circulating pumps are controlled by BAS with automatic switchover upon failure of the lead pump.

.5 The heat exchangers are designed with 100% redundancy with manually switchover.

.6 The gas-fired boilers operate in standby mode. When additional heat source is required the BAS will modulate the three-way control valve to divert water through the boilers.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control HWP-H007, HWP-H008, HWP-H016 and HWP-H017 through their respective local Hand-Off-Computer (HOC) switches provided by Division 16. Refer to Electrical drawings for more details.

.2 When the switch is placed in the 'Hand' position, the corresponding pump is energized.

.3 When the switch is placed in the 'Off' position, the corresponding pump is de-energized.

.4 When the switch is placed in the 'Computer' position, the operation of the corresponding pump shall follow the sequences described in the Sequence of

Operation section. A relay contact from the corresponding switch is energized indicating to BAS that the local switch is placed in the 'Computer' position

.4 **SEQUENCE OF OPERATION:**

.1 The BAS shall operate HWP-H016 and HWP-H017 continuously based on a Lead / Lag sequence

.2 The BAS shall operate HWP-H007 and HWP-H008 on an intermittent basis following the Lead / Lag sequence.

.3 The BAS shall control the condenser water supply temperature (T-H016B) within the lower limit of 13 ^{o}C (adjustable) and upper limit of 26 ^{o}C (adjustable) by means of modulating V-H018A and V-H019A and cycling the lead pump of HWP-H007 and HWP-H008.

.4 As additional heat is required the BAS shall modulate the V-H018 to divert more water flow through B-H018. Upon further call for heat when the V-H018 has reached the maximum diverting position, the BAS shall modulate the V-H019 to divert more water through B-H019. When the lower limit set-point is satisfied, the reverse sequence shall take place unload the heating capacity.

.5 On a call for cooling, the BAS shall energize the lead Cooling Water circulating pump following the lead / lag sequence. Provide proper time delay to ensure that the cooling water circulating pump would continue operating for not less than five minutes (adjustable) once it has been energized.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When BAS detects no water flow at FS-H007A while the lead Cooling Water circulating pump is supposed to be energized, follow the Lead/Lag control sequence to initiate alarms accordingly.

.2 When BAS detects no water flow at FS-H016A while the lead Condenser Water circulating pump is supposed to be energized, follow the Lead/Lag control sequence to initiate alarms accordingly.

.3 While the local HOC switches for any of the pump is not placed in the 'Computer' position, an Off-Line alarm is logged accordingly and an alarm is indicated.

EF-H005, EF-H006, EF-H040, EF-H044 SIMPLE EXHAUST FANS CONTROL SYSTEM

.1 **OBJECTIVES:**

.1 The objective of these systems is to provide continuous ventilation.

.2 **SYSTEM DESCRIPTION:**

.1 The following systems belong to this category:

.1 EF-H005, Chemical Injection Area Exhaust
.2 EF-H006, Ozone Mixing Chamber Exhaust
.3 EF-H040, Blower Room Exhaust
.4 EF-H044, Waste Storage Room Exhaust

.2 Each of these systems consists of an exhaust fan controlled by an ON/OFF local switch.

.3 The BAS monitors the status of the exhaust fans through their respective airflow switch, however the fan operation is controlled by the local switch. Control wiring between the exhaust fan and its local switch is provided by Division 16. Refer to wiring schematics on electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 The local interface is through the local ON/OFF switch described above.

.2 The local switch shall be left in ON position at all time.

.4 **SEQUENCE OF OPERATION:**

.1 No sequence of operation is required.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When the system airflow switch detects no airflow, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

EF-H015 MECHANICAL ROOM NO. 2
HEAT RELIEF VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The primary objective of this system is to reject the heat generated by the DAF air compressors to the atmosphere. In order to conserve building heat energy, this system also distributes the air compressor heat to the entire space of the Mechanical Room No.2, particularly to the location where combustion air supply terminates. The system will operate in such a manner that will minimize energy consumption.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of the following components:

.1 EF-H015: Exhaust Fan
.2 MD-H015A: Outside air motorized damper (open/close)
.3 MD-H015B: Exhaust air motorized damper (modulating)
.4 MD-H015C: Re-circulation motorized damper (modulating)
.5 T-H015D: Room temperature sensor
.6 SM-H015E: Duct smoke detector
.7 FS-H015F: Airflow pressure differential switch

.2 The BAS will continuously control the operation MD-H015A, MD-H015B and MD-H015C based on the temperature sensed by T-H015D.

.3 A local Hand-Off-Computer (HOC) switch for EF-H015 and its control wiring shall be provided by Division 16. See Electrical drawings for details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control EF-H015 through the local Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H015 is de-energized

.3 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 EF-H015 is energized

.4 When the switch is placed in the 'Computer' position, EF-H015 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

EF-H015 MECHANICAL ROOM NO. 2
HEAT RELIEF VENTILATION SYSTEM

.4 **SEQUENCE OF OPERATION:**

.1 When T-H015D is lower than 25 ^{o}C (adjustable) the following sequence shall take place:

.1 EF-H015 is de-energized
.2 MD-H015A closed
.3 MD-H015B fully closed
.4 MD-H015C fully open

.2 When T-H015D is at or higher than 25 ^{o}C (adjustable) but lower than 27 ^{o}C (adjustable) the following sequence shall take place:

.1 EF-H015 is energized
.2 MD-H015A closed
.3 MD-H015B fully closed
.4 MD-H015C fully open

.3 When T-H015D is at or higher than 27 ^{o}C (adjustable) the following sequence shall take place:

.1 EF-H015 is energized
.2 MD-H015A open
.3 MD-H015B and MD-H015C modulate according to the following linear schedule:
  .1 T-H015D = 27 ^{o}C
    .1 MD-H015B fully closed
    .2 MD-H015C fully open
  .2 T-H015D = 34 ^{o}C
    .1 MD-H015B fully open
    .2 MD-H015C fully closed.

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H015D reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When SM-H015E detects smoke in the ductwork, a Smoke Alarm is logged and an Automatic Smoke Detection Shutoff sequence shall be initiated.

.3 When FS-H015F detects no airflow while EF-H015 is supposed to be operating, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.4 While the local HOC switch of EF-H015 is not placed in the ‘Computer’ position, an Off-Line alarm is logged and an alarm is indicated.

EF-H041 MECHANICAL ROOM NO. 3
HEAT RELIEF VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heat relief ventilation for the Mechanical Room No.3.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an exhaust fan (EF-H041), an exhaust damper (MD-H041A) and a room temperature sensor (T-H041B)

.2 BAS controls the operation of EF-H041 based on the temperature detected by T-H041B. Control wiring between EF-H041 and its interlocking motorized damper MD-H041A is the work of Division 16. Refer to Electrical drawings for more details

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H041 is de-energized
.2 MD-H041A closed

.3 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 EF-H041 is energized
.2 MD-H041A open

.4 When the switch is placed in the 'Computer' position, EF-H041 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION:**

.1 When T-H041B detects temperature lower than 25 ^{o}C (adjustable) EF-H041 is de-energized.

.2 When T-H041B detects temperature at or higher than 25 ^{o}C (adjustable) EF-H041 is energized.

EF-H041 MECHANICAL ROOM NO. 3
HEAT RELIEF VENTILATION SYSTEM

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H041B reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When FS-H041C detects no airflow while EF-H041 is supposed to be operating, a Fan Failure Alarm is logged and a Equipment Failure Alarm sequence shall be initiated.

EF-H043 MAINTENANCE WORKSHOP AREA
SANITARY EXHAUST SYSTEM

.1 **OBJECTIVES:**

.1 The main objective of this system is to provide ventilation for the Washrooms within the Maintenance Workshop Area.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an exhaust fan (EF-H043) and an exhaust motorized damper (MD-H043A).

.2 The operation of EF-H043 is controlled by the BAS. Control wiring between the exhaust fan and its interlocking damper is the work of Division 16. Refer to electrical drawing for additional details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI, the Operator can also manually control EF-H043 through a local Hand-Off-Computer (HOC) switch provided by Division 16.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 MD-H043A open
.2 EF-H043 is energized, interlocked with MD-H043A

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 MD-H043 closed
.2 EF-H043 is de-energized

.4 When the switch is placed in the 'Computer' position, the operation of the fan shall follow the sequences described in the Sequence of Operation section. A relay contact, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION**

.1 This system shall operate intermittently as described below and subject to alarm condition.

.2 During unoccupied periods, based on preset occupied schedule, the BAS de-energizes EF-H043.

.3 During occupied period, the BAS de-energizes EF-H043.

EF-H043 MAINTENANCE WORKSHOP AREA
SANITARY EXHAUST SYSTEM

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When FS-H043B detects no airflow while EF-H043 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.2 While the local HOC switch of EF-H043 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

EF-H063 AND EF-H065 FIRE PUMP ROOM
GENERAL AND HEAT RELIEF VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide general and heat relief ventilation for the Fire Pump Room.

.2 **SYSTEM DESCRIPTION:**

.1 The general exhaust system consists of an exhaust fan (EF-H063), an outside air intake motorized damper (MD-H063A) and an exhaust motorized damper (M-H063B).

.2 The heat relief exhaust system consists of an exhaust fan (EF-H065), an outside air intake motorized damper (MD-H065A), an exhaust motorized damper (MD-H065B) and a room temperature sensor (T-H065D).

.3 Control wirings between EF-H063 and EF-H065 and their associated motorized dampers is the work of Division 16. Refer to Electrical drawings for more details

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI, the Operator can also manually control EF-H063 and EF-H065 through their respective local Hand-Off-Computer (HOC) switch provided by Division 16.

.2 When each of these switches is placed in the 'Hand' position, the following sequence shall take place for each respective fan:

.1 EF-H063 is energized
.2 MD-H063A open
.3 MD-H063B open
.4 EF-H065 is energized
.5 MD-H065A open
.6 MD-H065B open

.3 When each of these switches is placed in the 'Off' position, the following sequence shall take place for each respective fan:

.1 EF-H063 de-energized
.2 MD-H063A closed
.3 MD-H063B closed
.4 EF-H065 de-energized
.5 MD-H065A closed
.6 MD-H065B closed

.4 When each of these switches is placed in the 'Computer' position, the operation of the respective fan shall follow the sequences described in the Sequence of Operation section. A relay contact for each of these switches, provided by Division

16, shall close indicating to BAS that the local switch is placed in the 'Computer' position

.4 **SEQUENCE OF OPERATION:**

.1 The BAS energizes EF-H063 on an intermittent basis to provide general ventilation for the room. Initially this system is energized for 15 minutes (adjustable) every 1 hour (adjustable).

.2 The BAS controls EF-H065 based on room temperature detected by T-H065D. When T-H065D detects temperature lower than 25 ^{o}C (adjustable) the following sequence EF-H065 is de-energized.

.3 When T-H065D detects temperature at or higher than 25 ^{o}C (adjustable) the following sequence EF-H065 is energized

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H065D reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When FS-H063C detects no airflow while EF-H063 is supposed to be operating, a Fan Failure Alarm is logged and a Equipment Failure Alarm sequence shall be initiated.

.3 When FS-H065C detects no airflow while EF-H065 is supposed to be operating, a Fan Failure Alarm is logged and a Equipment Failure Alarm sequence shall be initiated.

EF-H064 MECHANICAL ROOM NO. 1
HEAT RELIEF VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heat relief ventilation for the Mechanical Room No. 1.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an exhaust fan (EF-H064), an intake damper (MD-H064A), and exhaust damper (MD-H064B) and a room temperature sensor (T-H064C)

.2 BAS controls the operation of EF-H064 based on the temperature detected by T-H064C. Control wiring between EF-H064 and its interlocking motorized dampers MD-H064A and MD-H064B is the work of Division 16. Refer to Electrical drawings for more details

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H064 is de-energized
.2 MD-H064A closed
.3 MD-H064B closed

.3 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 EF-H064 is energized
.2 MD-H064A open
.3 MD-H064B open

.4 When the switch is placed in the 'Computer' position, EF-H064 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION:**

.1 When T-H064C detects temperature lower than 25 ^{o}C (adjustable) EF-H064 is de-energized.

.2 When T-H064C detects temperature at or higher than 25 ^{o}C (adjustable) EF-H064 is energized.

EF-H064 MECHANICAL ROOM NO. 1
HEAT RELIEF VENTILATION SYSTEM

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H064C reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When FS-H064D detects no airflow while EF-H064 is supposed to be operating, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

EF-H073 ADMINISTRATION AREA
SANITARY EXHAUST SYSTEM

.1 **OBJECTIVES:**

.1 The main objective of this system is to provide ventilation for the Main Washrooms, Locker Rooms and Janitor Room within the Administration Area.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an exhaust fan (EF-H073) and an exhaust motorized damper (MD-H073A).

.2 The operation of EF-H073 is controlled by the BAS. Control wiring between the exhaust fan and its interlocking damper is the work of Division 16. Refer to electrical drawing for additional details.

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI, the Operator can also manually control EF-H073 through a local Hand-Off-Computer (HOC) switch provided by Division 16.

.2 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 MD-H073A open
.2 EF-H073 is energized, interlocked with MD-H073A

.3 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 MD-H073 closed
.2 EF-H073 is de-energized

.4 When the switch is placed in the 'Computer' position, the operation of the fan shall follow the sequences described in the Sequence of Operation section. A relay contact, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION**

.1 This system shall operate intermittently as described below and subject to alarm condition.

.2 During unoccupied periods, based on preset occupied schedule, the BAS de-energizes EF-H073.

.3 During occupied period, the BAS de-energizes EF-H073.

.5 **ALARMS:**

EF-H073 ADMINISTRATION AREA
SANITARY EXHAUST SYSTEM

.1 The following system alarms are indicated at the HMI:

.1 When FS-H073B detects no airflow while EF-H073 is supposed to be energized, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

.2 While the local HOC switch of EF-H073 is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm is indicated.

EF-H074 MECHANICAL ROOM NO. 4
HEAT RELIEF VENTILATION SYSTEM

.1 **OBJECTIVES:**

.1 The objective of this system is to provide heat relief ventilation for the Mechanical Room No.4.

.2 **SYSTEM DESCRIPTION:**

.1 This system consists of an exhaust fan (EF-H074), an exhaust damper (MD-H074A) and a room temperature sensor (T-H074B)

.2 BAS controls the operation of EF-H074 based on the temperature detected by T-H074B. Control wiring between EF-H074 and its interlocking motorized damper MD-H074A is the work of Division 16. Refer to Electrical drawings for more details

.3 **LOCAL OPERATOR INTERFACE:**

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H074 is de-energized
.2 MD-H074A closed

.3 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 EF-H074 is energized
.2 MD-H074A open

.4 When the switch is placed in the 'Computer' position, EF-H074 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION:**

.1 When T-H074B detects temperature lower than 25 ^{o}C (adjustable) EF-H074 is de-energized.

.2 When T-H074B detects temperature at or higher than 25 ^{o}C (adjustable) EF-H074 is energized.

EF-H074 MECHANICAL ROOM NO. 4
HEAT RELIEF VENTILATION SYSTEM

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H074B reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When FS-H074C detects no airflow while EF-H074 is supposed to be operating, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

EF-H067 ADMINISTRATION AREA ELECTRICAL CLOSET HEAT RELIEF VENTILATION SYSTEM

.1 OBJECTIVES:

.1 The objective of this system is to provide heat relief ventilation for the Electrical Closet in the Administration Area.

.2 SYSTEM DESCRIPTION:

.1 This system consists of an exhaust fan (EF-H067), an exhaust damper (MD-H067A) and a room temperature sensor (T-H067B)

.2 BAS controls the operation of EF-H067 based on the temperature detected by T-H067B. Control wiring between EF-H067 and its interlocking motorized damper MD-H067A is the work of Division 16. Refer to Electrical drawings for more details

.3 LOCAL OPERATOR INTERFACE:

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control this system through the local Hand-Off-Computer (HOC) switch.

.2 When the switch is placed in the 'Off' position, the following sequence shall take place:

.1 EF-H067 is de-energized
.2 MD-H067A closed

.3 When the switch is placed in the 'Hand' position, the following sequence shall take place:

.1 EF-H067 is energized
.2 MD-H067A open

.4 When the switch is placed in the 'Computer' position, EF-H067 operation shall follow the sequences described in the Sequence of Operation section. A relay contact provided by Division 16 shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 SEQUENCE OF OPERATION:

.1 When T-H067B detects temperature lower than 25 ^{o}C (adjustable) EF-H067 is de-energized.

.2 When T-H067B detects temperature at or higher than 25 ^{o}C (adjustable) EF-H067 is energized.

EF-H067 ADMINISTRATION AREA ELECTRICAL CLOSET HEAT RELIEF VENTILATION SYSTEM

.5 **ALARMS:**

.1 The following system alarms are indicated at the HMI:

.1 When T-H067B reaches 40 ^{o}C or higher, a High Temperature Alarm is logged and a High Temperature Alarm sequence shall be initiated

.2 When FS-H067C detects no airflow while EF-H067 is supposed to be operating, a Fan Failure Alarm is logged and an Equipment Failure Alarm sequence shall be initiated.

ELECTRIC RADIANT HEATERS (ERH) AIR INTAKE BIRDSCREEN DEFROSTING SYSTEM

.1 OBJECTIVES:

.1 The objective of this system is to prevent the build-up of hoar frost on the birdscreens at the air intake louvers.

.2 SYSTEM DESCRIPTION:

.1 Each of these systems consists of a group of Electric Radiant Heaters (ERH) and a pressure differential sensor (DP-H0xx) which senses the differential pressure between the intake plenum and outdoor.

.2 The ERH heaters are controlled by BAS based on the pressure differential detected by DP-H0xx and outside air temperature.

.3 The following is the list of Defrosting Systems and their associated ERH heaters and pressure differential sensors:

.1 Mechanical Room No. 2 System:

.1 ERH-H013A, B, C, D
.2 ERH-H014
.3 ERH-H015A, B, C, D
.4 DP-H010

.2 Mechanical Room No. 3 System:

.1 ERH-H038A, B
.2 ERH-H039
.3 ERH-H040
.4 DP-H020

.3 Mechanical Room No. 1 System:

.1 ERH-H066A, B, C
.2 DP-H040

.4 Mechanical Room No. 4 System:

.1 ERH-H071
.2 ERH-H072
.3 DP-H050

.3 LOCAL OPERATOR INTERFACE:

.1 In addition to the interface available at the HMI located in the Control Room, the Operator can also manually control each Defrosting System through the local Hand-Off-Computer (HOC) switch provided by Division 16. Refer to Electrical drawing for additional information..

ELECTRIC RADIANT HEATERS (ERH) AIR INTAKE BIRDSCREEN DEFROSTING SYSTEM

.2 When the switch is placed in the 'Hand' position, all the heaters within the group shall be energized

.3 When the switch is placed in the 'Off' position, all the heaters in the group shall be de-energized.

.4 When the switch is placed in the 'Computer' position, the operation of the heaters shall follow the sequences described in the Sequence of Operation section. A relay contact, provided by Division 16, shall close indicating to BAS that the local switch is placed in the 'Computer' position.

.4 **SEQUENCE OF OPERATION:**

.1 The BAS monitors the outdoor air temperature and pressure differential detected by DP-H0XX and controls the ERH heaters in the system as follows:

.1 When outdoor temperature is above 0 degree C (adjustable), the heaters shall be de-energized

.2 When outdoor temperature is at or below 0 degree C (adjustable) and DP-H0XX detects static pressure in the plenum 62 Pa (adjustable), the heaters shall be energized.

.5 **ALARMS:**

.1 The following system alarms shall be indicated at the HMI:

.1 While the local HOC switch is not placed in the 'Computer' position, an Off-Line alarm is logged and an alarm shall be indicated.

HVAC CONTROLS, FIELD COMPONENTS, AND INSTRUMENTS

1. GENERAL

1.1 General

.1 The requirements of this section shall be provided in addition to those listed in Section 15900, HVAC Instrumentation and Controls - General.

2. PRODUCTS

2.1 Motorized Dampers

.1 General:

.1 Specification applies to control dampers, except those specified to be furnished with equipment.

.2 Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

.2 High Performance Type:

.1 Frame: Frame: 127 mm by 25 mm by minimum 3.2 mm 6063-T5 extruded aluminum hat-shaped channel, mounting flanges on both sides of frame, reinforced at corners.

.2 Blades:

.1 Style: Airfoil-shaped, single-piece.

.2 Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.

.3 Material: Heavy duty 6063-T5 extruded aluminum.

.4 Width: Nominal 152 mm.

.3 Bearings: Molded synthetic sleeve, turning in extruded hole in frame.

.4 Seals:

.1 Blade Seals: Extruded neoprene type for ultra-low leakage from minus 58 to 135 ^{o}C. Mechanically attached to blade edge.

.2 Jamb Seals: Flexible metal compression type.

.5 Linkage: Concealed in frame.

.6 Axles:

.1 Minimum 13 mm diameter, hex-shaped, mechanically attached to blade.

.2 Material: Plated steel.

.7 Performance Data: As follows:

.1 Temperature Rating: Withstand minus 58 to 135 ^{o}C.

.2 Capacity: Demonstrate capacity of damper to withstand HVAC system operating conditions.

.3 Closed Position: Maximum pressure of 3.2 kPa at 305 mm blade length.

.4 Open Position: Maximum air velocity of 1,829 metre per minute.

.5 Leakage: Maximum 0.6 cubic metre per minute per square metre at 1 kPa for size 1219 by 1219 mm.

.6 Pressure Drop: Maximum 0.01 kPa at 457 metres per minute across 610 by 610 mm damper.

.8 Acceptable Manufacturers:

.1 Ruskin; Model CD-50.

.2 American Warming and Ventilating.

.3 TAMCO.

.3 Heavy Duty Type:

.1 Frame:

.1 203 mm by 51 mm by minimum 2 mm channel.

.2 Bolt Holes: Both flanges.

.3 Material: Type 316 stainless steel.

.2 Blades:

.1 Style: Airfoil-shaped, double-skin.

.2 Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.

.3 Minimum 2.0 mm (14 gauge) thickness.

.4 Material: Type 316 stainless steel.

.5 Width: 127 mm to 203 mm maximum.

.3 Bearings: Stainless steel sleeve pressed into frame.

.4 Seals:

.1 Blade Seals: Stainless steel blade seals, maximum 204 °C. Mechanically attached to blade edge.

.2 Jamb Seals: Compressible stainless steel located between blade edge and jamb.

.5 Linkage:

.1 Side linkage out of airstream.

.2 Constructed of minimum 3.5 mm (10-gauge) galvanized steel clevis arms with minimum 4.8 mm by 19 mm plated steel tie bars pivoting on minimum 9.5-mm diameter stainless steel pivot pins with lock-type retainers.

.6 Axles:

.1 Minimum 19 m diameter, hex-shaped, mechanically attached to blade.

.2 Material: Type 316 stainless steel.

.7 Performance Data: As follows:

.1 Maximum Operating Temperature: 121 °C.

.2 Maximum System Pressure: 250 Pa.

.3 Maximum System Velocity: 1,219 metre per minute.

.4 Leakage with Seals: Based on pressure differential of 250 Pa.

.1 Percent of Maximum Flow: 0.10.

.2 Leakage: 1.2 cubic metres per minute per square metres.

.5 Leakage without Seals: Based on pressure differential of 250 Pa.

.1 Percent of Maximum Flow: 0.80.

.2 Leakage: 9.7 cubic metres per minute per square metres.

.6 Ultra-Low Leakage where specified:

.1 Percent of Maximum Flow: 0.07.

.2 Leakage: 0.8 cubic metre per minute per square metre.

.8 Acceptable Manufacturers:

.1 Ruskin; Model CD-80AF.

.2 American Warming and Ventilating.

.3 TAMCO.

2.2 Damper Actuators

.1 General:

.1 Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).

.2 Select actual quantity of motors required to operate each damper in accordance with size of damper provided.

.3 Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.

.4 Provide operators for motorized dampers and motorized louvers.

.2 Electric Damper Actuators:

.1 Performance: As scheduled in Motorized Damper Schedule.

.2 Mounting: External side plate.

.3 Ample power to overcome friction of damper linkage and air pressure acting on damper blades.

.4 Furnished with external adjustable stops to limit stroke.

.5 Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.

.6 Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.

.7 Operating Torque:

.1 Provide multiple independent damper sections, each with separate actuator sized to provide a minimum of 120 percent of operating torque required by damper(s).

.2 Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 200 Pa air pressure on damper blades:

.1 Opposed-Blade Dampers: Minimum 6 Nm per square metre of damper area, unless higher values are recommended by damper manufacturer.

.2 Parallel-Blade Dampers: Minimum 8.5 Nm per square metre of damper area, unless higher values are recommended by damper manufacturer.

.8 Manufacturers:

.1 Honeywell

.2 Belimo.

.3 Siemens Building Technologies

.4 Johnson Controls.

2.3 Automatic Three-Way Control Valves (V-H018A and V-H019A)

.1 General:

.1 Valve shall be of diverting type

.2 Fully proportioning with modulating plugs for equal percentage of linear flow characteristics.

.3 Valve Body and Trim: Sufficient to handle system pressure and temperature.

.4 Sized for a maximum pressure drop of 34.5 kPa.

.2 Valves 12 mm Through 32 mm:

.1 Constructed with cast brass body and screwed ends.

.2 Trim: Removable cage providing valve plug guiding throughout entire travel range.

.3 Type 316 stainless steel stem.

.4 Removable bonnet, cage, stem, and plug assembly.

.3 Valve Actuators:

.1 Sufficient power for intended duty.

.2 Capable of closing against differential pressures to be encountered.

.3 Constructed and piped to fail to full heating upon loss of control signal.

.4 Manufacturers:

.1 Honeywell.

.2 Siemens Building Technologies.

.3 Johnson Controls.

2.4 Electric Thermostats

.1 Unit Heaters and Electric Convectors Room Thermostat (T):

.1 Modulating electric type, except where two-position action is required.

.2 Temperature Scale: Furnish 10 to 32 ^{o}C dial.

.3 External adjustments.

.4 Adjustable sensitivity.

.5 Nonlocking cover.

.6 Insulating back where exterior wall mounting is indicated..

2.5 Electronic Sensors

.1 Temperature:

.1 General Requirements:

.1 Sensors and transmitters shall be provided, as outlined in control schematics and sequence of operations.

.2 Temperature sensor shall resistance type, and shall be either two-wire 1,000-ohm nickel RTD or two-wire 1,000-ohm platinum RTD.

.3 The following point types (and accuracy of each) are required, and their associated accuracy values include errors associated with sensor, lead wire, and A to D conversion:

Point Type	Accuracy
Cooling Water and	$\pm$ 0.3°C.

HVAC CONTROLS, FIELD COMPONENTS, AND INSTRUMENTS

Point Type	Accuracy
Condenser Water	
Room Temperature	± 0.3°C.
Duct Temperature	± 0.3°C.
All Others	± 0.4°C.

.2 Room Temperature Sensor with Integral Display [T]:

.1 Constructed for either surface or wall box mounting.

.2 Nonlocking wire protective guards for room temperature sensors installed in process areas.

.3 Integral LCD room temperature display

.3 Water Temperature [T]:

.1 Accuracy: Plus or minus 0.5 ^{o}C.

.2 Range: minus 1 to 38 ^{o}C.

.3 Element: Removable insertion into pipe thermowell.

.4 Cover: NEMA-4 Type, suitable for area classification; in accordance with NFPA 70.

.4 Outdoor Temperature [To]:

.1 Accuracy: Plus or minus 0.5 ^{o}C.

.2 Range: Minus 40 to 60 ^{o}C.

.3 Cover: Weathertight, with sealed conduit connection and sun shield.

.2 Differential Pressure:

.1 General:

.1 Temperature compensated.

.2 Vary output voltage with change in differential pressure. Voltage shall vary linearly from 0 to 10V dc according to differential pressure between high and low pressure ports.

.3 Sensing range shall be suitable for application with linearity of 1.5 percent of full scale and offset of less than 1 percent of full scale.

.4 Capable of withstanding up to 150 percent of rated pressure without damage.

.5 Compatible with 14V to 30V dc supply voltage range.

.2 Pressure Differential Sensor (PD):

.1 MAMAC Low pressure Transducer

.2 100% solid state, micro-machined, glass-on-silicon, ultra-stable capacitance sensor

.3 Up to 6 field selectable ranges in one unit

.4 Two temperature compensated output versions, 4-20mA 2-wire or field selectable 0-5 VDC/0-10 VDC

.5 NEMA 4 enclosure

.6 Up to 10 psid overpressure without zero shift

.7 Provide all necessary accessories for each specific application.

.8 Manufacturer: MAMAC System, Model PR-275/275.

.3 Airflow Switch (FS) and Pressure Differential Switch (PS)

.1 General Description:

.1 Differential Pressure switch used for sensing airflow in ducts and filter loaded condition by means of pressure differential

.2 Unit shall consist of two sensing ports; one on each side of a spring load diaphragm, which moves to actuate the SPDT switch.

.2 Materials:

.1 Diaphragm: Buna-N

.2 Body and Wiring Compartment Enclosure: Molded polycarbonate

.3 Cover and diaphragm housing: 0.8mm cold rolled steel, zinc plated.

.3 Operating Condition:

.1 Ambient Temperature: -40 deg. C to 75 deg. C

.2 Maximum pressure: 6.9 kPa

.4 Accessories

.1 Provide all connector fittings, mounting brackets and sensing tubes required for the application indicated in this specification and drawings.

.3 Water Flow Switch (FS):

.1 Dual Turbine Type:

.1 Material: Wetted metal parts, bright tin-plated brass.

.2 Sensing Method: Electronic impedance sensing, nonmagnetic and nonphotoelectric.

.3 Accuracy:

.1 Plus or minus 0.5 percent of reading at calibrated velocity.

.2 Plus or minus1 percent of reading from 0.9 to 9.1 metre per second (10:1 range).

.3 Plus or minus 2 percent of reading from 0.12 to 6.1 metre per sec (50:1 range).

.4 Pressure Drop: Less than 6.9 kPa at 6.1 metre per sec in 65 mm pipe, decreasing for larger pipe sizes and lower velocities.

.5 Maximum Operating Pressure: 2757 kPa.

.6 Standards Compliance: Meets or exceeds, for respective pipe or tube size, accuracy, head loss, flow limits, pressure and material requirements of AWWA C704.

.7 Supply Voltage: 24V plus or minus 4V ac/dc at 50 mA.

.8 Electrical Connections: 3 wire minimum for 4-20 mA or 0-10 V DC output.

.9 Nonisolated Analog Output:

.1 Noninteractive ZERO and SPAN adjustments.

.2 DC Linearity: 0.1 percent of span.

.3 Voltage Output: 0-10V.

.4 Current Output: 4-20 mA.

.10 Frequency Output: 0-15 V DC, peak pulse.

.11 Manufacturer and Product: Onicon; F-1200 Dual Turbine.

2.6 Temperature Controllers

.1 WSHP Zone Controllers [T]

.1 Communicating Programmable Room Thermostat specifically designed for controlling heat pump systems.

.2 Network Communication: LonWorks Bus and PDA Serial Port

.3 Individual heat and cool set-points

.4 PID Control to minimize temperature fluctuations

.5 Occupied Switch overriding unoccupied setback

.6 Capable of communicating with the Building Automation System (BAS) the following:

.1 Room Temperature

.2 Heating Set Point

.3 Cooling Set point

.4 Occupied Switch Status

.5 Filter Change Status

.7 Temperature Range: 15 to 30 ^{o}C.

.8 System Mode Switch: Heating, Cooling, Auto, Off

.9 Fan Switch: On, Auto

.10 Manufacturers:

.1 Honeywell, Model T7350H

.2 Johnson Controls, approved equal

2.7 Miscellaneous Devices

.1 General:

.1 RTD to voltage (0- to 5-volt) converters with zero span adjustments for use with analog inputs.

.2 Limited range thermistors are acceptable provided they sense expected range for point at specified accuracy with 0- to 5-volt output.

.3 Auxiliary contacts in each motor starter, Work of Division 16, Electrical.

.4 START/STOP relay module for either momentary or maintained switch action as indicated.

.2 Pilot Relays:

.1 Plug-in type.

.2 Interchangeable.

.3 Mounted on a circuit board.

.4 Wired to numbered terminal strips.

.3 Motorized Step Controllers: Furnish with adjustable (from minus 17 to minus 12 oC) deadband between heating and cooling functions.

.4 Manual Timer (MT):

.1 12-hour, SPST, 120-volt, 20-amp.

.2 Spring wound.

.3 HOLD feature to override the time clock during off-hour operation.

.4 Install on front cover of HCP.

.5 Acceptable Manufacturers:

.1 Marktime.

.2 Dayton.

.3 Nutone.

.5 Carbon Monoxide (CO) Detectors

.1 Range: 0-500 ppm

.2 Accuracy: +/- 3% at 5-45 deg. C and 15-95% RH

.3 Sensing Element: Electrochemical

.4 Operating Condition: 0-50 deg.C, 15-95% RH non-condensing

.5 Sample Method: Diffusion or flow through

.6 Stability: Less than 5% signal loss per year

.7 Output Signal: 4-20 mA, 0-5 Vdc or 0-10 Vdc

.8 LCD Display of CO concentration in ppm

.9 Response time: Under 30 seconds for 90% step change

.10 Power supply: 20-30 Vac/dc

.11 Acceptable Manufacturers:

.1 Greystone Energy Systems Inc., CMD-5-B-2-10-1

.6 Carbon Dioxide (CO2) Detectors

.1 Range: 0-2000 ppm

.2 Accuracy: +/- 75 ppm or 3% at 15-32 deg.C

.3 Sensing Element: Non-dispersive infrared

.4 Operation Condition: 0-50 deg.C, 0-95% RH non-condensing

.5 Stability: +/- 20 ppm every 5 years

.6 Output signal: 4-20 mA, 0-5Vdc and 0-10Vdc

.7 Response time: under 60 seconds for 90% step change

.8 Power Supply: 20-30 Vac/dc

.9 Acceptable Manufacturers:

.1 Greystone Energy Systems Inc., CDD-1-A-6-10

.7 Duct Mounted Ionization Detection (I):

.1 Refer to Section 13850, Fire Detection and Alarm, for requirements.

.2 Supply and install duct smoke detectors for air handling systems, number and location as shown on Drawings.

.3 Type: Duct mounted, suitable for airstream sensing.

.4 Voltage: 120V ac.

.5 Detector Type: Ionization.

.6 Furnish with remote reset button or key switch.

.7 Include mounting bracket for installation on the ductwork.

.8 Coordinate with other trades to accomplish specified Automatic Smoke Detection shutoff control sequence.

.9 Acceptable Manufacturers:

.1 BRK Electronics; Model DH1851AC.

.2 Pyrotronics Pyr-Alarm; Model CA-4.

3. EXECUTION

3.1 Installation

.1 Control Dampers:

.1 Install at locations indicated on Drawings and in accordance with manufacturer's instructions.

.2 Install square and free from racking with blades running horizontally.

.3 Operate opposed blade dampers from a power blade or drive axle.

.4 Bracing:

.1 Install for multiple section assemblies to support assembly weight and to hold against system pressure.

.2 Install at every horizontal and vertical mullion.

3.2 Supplements

.1 The supplements listed below, following "END OF SECTION," are part of this Specification.

.1 15901-01 Motorized Damper (MD) Schedule.

END OF SECTION

MOTORIZED DAMPER (MD) SCHEDULE
15901-01

EQUIPMENT TAGS	AREA SERVED	AIRLFOW CAPACITY	TYPE	NORMAL POSITION	DIMENSIONS		ACTUATOR			REMARKS
					WIDTH	HEIGHT	QTY.	POWER SUPPLY		
		L/s			[mm]	[mm]		Volt	Ph	
MD-H004A	Filter Gallery Exhaust	5,660	TP,PB,SP,INS	CLOSE	1000	750	1	115	1	
MD-H013A	Pilot Plant Exhaust	2,642	TP,PB,SP,INS	CLOSE	750	550	1	115	1	
MD-H0014A	Residuals Handling Area Exhaust	6,934	TP,PB,SP,INS	CLOSE	1100	800	1	115	1	
MD-H0015A	Mechanical Room No. 2 H.R. Intake	6,038	TP,PB,SP,INS	CLOSE	1800	3000	2	115	1	(1)
MD-H0015B	Mechanical Room No. 2 H.R. Exhaust	6,038	OB,MD,INS	---	1000	800	1	24	1	(1)
MD-H0015C	Mechanical Room No. 2 H.R. Recirculation	6,038	OB,MD	---	900	900	1	24	1	(1)
MD-H0023A	Ozone Generator Room Emergency Exhaust	10,660	TP,PB,SP,INS	OPEN	1500	850	1	115	1	(2)
MD-H0037A	Polymer Preparation & Feed Room Exhaust	2,358	TP,PB,SP,INS	CLOSE	550	550	1	115	1	
MD-H0038A	Peroxide Storage and Feed Room Exhaust	1,038	TP,PB,SP,INS	CLOSE	450	400	1	115	1	
MD-H0039A	SBS Storage and Feed Room Exhaust	1,321	TP,PB,SP,INS	CLOSE	500	450	1	115	1	
MD-H041A	Mechanical Room No.3 H.R. Ventilation Exhaust	283	TP,PB,SP,INS	CLOSE	300	300	1	115	1	
MD-H043A	Maintenance Workshop Area Sanitary Exhaust	106	TP,PB,SP,INS	CLOSE	200	200	1	115	1	
MD-H052A	DAF Process Gallery Exhaust	12,877	TP,PB,SP,INS	CLOSE	1600	800	1	115	1	
MD-H063A	Fire Pump Room General Ventilation Intake	448	TP,PB,SP,INS	CLOSE	1200	300	1	115	1	
MD-H063B	Fire Pump Room General Ventilation Exhaust	448	TP,PB,SP,INS	CLOSE	300	300	1	115	1	
MD-H064A	Mechanical Room No.1 H.R. Ventilation Intake	189	TP,PB,SP,INS	CLOSE	400	400	1	115	1	
MD-H064B	Mechanical Room No.1 H.R. Ventilation Exhaust	189	TP,PB,SP,INS	CLOSE	400	400	1	115	1	
MD-H065A	Fire Pump Room H.R. Ventilation Intake	1,509	TP,PB,SP,INS	CLOSE	1200	900	1	115	1	
MD-H065B	Fire Pump Room H.R. Ventilation Exhaust	1,509	TP,PB,SP,INS	CLOSE	600	600	1	115	1	
MD-H067A	Administration Area Elect. Rm Exhaust	189	TP,PB,SP,INS	CLOSE	300	300	1	115	1	
MD-H071A	Administration Area Return Air	1,521	OB,MD	---	450	450	1	24	1	(1)
MD-H071B	Administration Area Exhaust Air	1,521	OB,MD,INS	---	450	450	1	24	1	(1)
MD-H072A	Laboratory Fume Hood Exhaust	189	TP,PB,SP,INS	CLOSE	300	300	1	115	1	
MD-H073B	Administration Area Sanitary Exhaust	731	TP,PB,SP,INS	CLOSE	400	400	1	115	1	
MD-H074A	Mechanical Room No.4 H.R. Ventilation Exhaust	283	TP,PB,SP,INS	CLOSE	300	300	1	115	1	

LEGEND:

OB - OPPOSED BLADE
PB - PARALLEL BLADE
MD - MODULATING
TP - TWO POSITIONS
SR - SPRING RETURN
INS - INSULATED

REMARKS:

1 Power and controlled by Building Automation System. All others are powered and controlled by Division 16
2 Div 16 to provide control wiring such that damper is energized to close, spring to open.
3 Actuator quantities are estimated. The Contractor shall determine the number of actuators required to achieve the specified sequences of operation.

MICROELECTRONIC CONTROL COMPONENTS

1. GENERAL

1.1 General

.1 This Section is a supplement to Section 15900, HVAC Instrumentation and Controls - General.

.2 The requirements of this Section shall be provided in addition to those listed in Section 15900, HVAC Instrumentation and Controls - General.

1.2 Definitions

.1 The following terms apply only to this Section of the specification. Refer to Special Conditions, Part D, for additional definitions which apply to the entire document

.2 ASCII: ANSI X3.4, Information Systems - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII).

.3 BACnet: ASHRAE 135, BACnet, Data Communication Protocol for Building Automation and Control Networks.

.4 Distributed Control: System whereby control processing is decentralized and independent of central computer. Control system is built up of standalone controllers. Single controller failure shall not impact more than one system.

.5 Ethernet: ISO/IEC 8802-3. The most common high performance peer-to-peer LAN protocol.

.6 Integration:

.1 Ability of control system components from different manufacturers to connect together and provide coordinated control via real-time data exchange through common communications data exchange protocol.

.2 Integration shall extend to operator's workstation software, which shall support user interaction with control system components.

.3 Methods of integration include industry standard protocols, such as: BACnet, LonMark/LonTalk, OPC, or integrator interfaces between manufacturer's systems.

.7 Interoperability: Ability of equipment to communicate mutually.

.8 Input/Output (I/O): Connections between computer and sensors and actuators.

.9 IP: Network layer protocol originally created by Defense Advanced Research Project Agency to facilitate data communication between U.S. Defense Department and defense contractors, including universities and manufacturers

MICROELECTRONIC CONTROL COMPONENTS

.10 LAN: Network in which devices can communicate directly without going through intervening routers. LANs commonly used by DDC system Manufacturer include Ethernet (ISO 8802-3), ARCNET, Echelon LonTalk, and EIA 485.

.11 MS/TP: One of the data link layers created specifically for use with BACnet messages.

.12 Network:

.1 System of distributed control units that are linked together on communication highway.

.2 Allows sharing of point information between control units.

.3 Provides central monitoring and control of entire system from any distributed control unit location.

.4 Primary networks provide peer-to-peer communications.

.5 Secondary networks provide either peer-to-peer, master-slave, or supervised token-passing communications.

.13 Peripheral: Input/Output equipment used to communicate with computer and make copies of system outputs. Peripherals include CRT, printer, tape deck, diskette.

.14 PID Control Loop: Mathematical calculation used to evaluate control input and determine control output value required to maintain input value at set point. Shall have operator adjustable maximum rate of change, P and D gains, and loop response time delay. Loop shall be self-integrating so no integral constant is required and not be subject to integral windup.

.15 TCP: Connection-oriented protocol used to convey multiple related messages (e.g., file transfers, Web pages, etc.).

.16 Abbreviations that may be used in this Section:

.1 BIOS: Basic Input Output System.

.2 DDC: Direct Digital Control.

.3 IBM: International Business Machines, Inc.

.4 LCD: Liquid Crystal Display.

.5 PC: Personal Computer..

.6 PI: Pressure Indicator.

1.3 Quality Assurance

.1 Compatibility:

.1 System shall have documented history of compatibility by design for minimum of 15 years.

.2 Future compatibility shall be supported for no less than 10 years.

.3 Compatibility shall be determined as:

.1 Ability to upgrade existing microelectronic controllers to current level of technology, and extend new microelectronic controllers on previously installed network.

.2 Ability for any existing microelectronic controller microprocessor to be connected and directly communicate with new microelectronic controllers without bridges, routers, or protocol converters.

1.4 System Performance

.1 System shall conform to the following performance standards:

.1 Graphic Display:

.1 Minimum of 20 dynamic points.

.2 Current data displayed within 20 seconds of request.

.2 Graphic Refresh: System shall update dynamic points with current data within 30 seconds.

.3 Object Command:

.1 Maximum time between command of binary object by operator and reaction by device shall be 10 seconds.

.2 Analog objects shall start to adjust within 10 seconds.

.4 Object Scan: Changes of state and change of analog values shall be transmitted over high-speed network such that any data used or displayed at controller or workstation will be current, within prior 60 seconds.

.5 Alarm Response Time: Maximum time from when object goes into alarm to when it is annunciated at workstation shall not exceed 45 seconds.

.6 Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with mechanical process under control.

.7 Performance: Programmable Controllers shall be able to execute DDC PID control loops at selectable frequency from at least once every 5 seconds. Controller shall scan and update process value and output generated by this calculation at this same frequency.

.8 Multiple Alarm Annunciation: Workstations on network shall receive alarms within 5 seconds of each other.

.9 Reporting Accuracy: Table 1 lists minimum acceptable reporting accuracies for values reported by specified system.

Table I -- Reporting Accuracy

Measured Variable	Reported Accuracy
Space temperature	±0.5°C
Ducted air temperature	±1.0°C
Outside air temperature	±1.0°C
Water temperature	±0.5°C
Delta-T	±0.15°C
Relative humidity	±5% RH
Water flow	±5% of full scale
Air pressure (ducts)	±25 Pa
Air pressure (space)	±3 Pa
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO_2)	± 50 PPM

2. PRODUCTS

2.1 Network Communication

.1 Control products for Networked DDC Control System shall comprise a BACnet network. PC Workstations and Building Controller components shall meet ASHRAE 135, BACnet.

.2 Operator Workstations and Building Controllers shall be installed on a primary high-speed peer-to-peer ISO 8802-3 Ethernet network.

.3 Custom Application Controllers and Application Specific Controllers may be installed on either primary high-speed peer-to-peer ISO 8802-3 Ethernet network, or Secondary network.

.4 Provide all communication media, connectors, repeaters, hubs, and routers necessary for network.

.5 Building Controllers shall have communications port for connections with operator interfaces using BACnet Data Link/Physical layer protocol.

.6 Provide device on network with minimum 28,000 baud modem that will allow remote operator interface using BACnet Data Link/Physical layer protocol. Modem shall allow for communication with controllers on this network as described below.

.7 Communications services over network shall result in operator interface and value passing that is transparent to network architecture as follows:

.1 Connection of operator interface device to any one controller on network shall allow operator to interface with other controllers as if that interface were directly connected to other controllers.

.2 Data, status information, reports, system software, custom programs for controllers shall be available for viewing and editing from any controller on network.

.3 Database values (i.e., points, software variable, custom program variables) of any one controller shall be readable by any other controller on network.

.4 This value passing shall be automatically performed by controller when reference to point name not located in that controller is entered into controller's database.

.5 Operator shall not be required to set up any communications services to perform network value passing.

.8 Time clocks in controllers shall be automatically synchronized daily.

2.2 Network Human-Machine Interface

.1 Operator Interface:

.1 Furnish one PC based operator workstation. The workstation shall be located in the Control Room.

.2 Workstation shall be able to access all information in system.

.3 Workstation shall reside on same high-speed network as building controllers, and shall also be able to dial into system.

.2 Hardware: Each operator workstation shall consist of the following:

.1 Personal Computer:

.1 Supply one IBM compatible PC.

.2 Features:

.1 Monitor: 432 mm, minimum, SVGA.

.2 CPU: Intel Pentium 4, minimum, and operate at a minimum of 3.0 GHz.

.3 RAM: 512 Megabytes, minimum.

.4 Diskette Drive: One with 1.44 Megabytes capacity.

.5 Optical Drive: 48X speed, DVD-ROM / CD-RW.

.6 Hard Drive: 80 GigaByte capacity, minimum, with maximum access time of 9.0 milliseconds.

.7 Mouse: Two button.

.3 Furnish required serial, parallel, and network communication ports, and cables for proper system operation.

.2 Modem:

.1 Auto-dial telephone modem and associated cables as required for communication to remote buildings, and workstations.

.2 Transmit at minimum of 56,000 baud, and communicate over voice-grade telephone lines.

.3 Printer:

.1 Each workstation shall have one ink jet printer, and associated cables.

.2 Capable of minimum 6 pages per minute operation and compatible with standard USB port communications.

.3 Supply one box of minimum 2000 sheets of printer paper and 2 printer cartridges.

.4 BACnet:

.1 Workstation shall use Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135, to communicate with BACnet objects in network.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.3 System Software:

.1 Operating System:

.1 Commercially available, concurrent multitasking.

.2 Support use of other common software applications that operate under Microsoft Windows.

.3 Acceptable operating systems are newest release of Windows or Windows XP.

.2 System Graphics:

.1 Operator workstation software shall be graphically oriented.

.2 System shall allow display of up to 10-graphic screens at once for comparison and monitoring of system status.

.3 Provide method for operator to easily move between graphic displays and change size and location of graphic displays on screen.

.4 Able to be modified while on line.

.5 Operator with proper password level shall be able to add, delete, or change dynamic points on graphic.

.6 Dynamic points shall include analog and binary values, dynamic text, static text, video and animation files.

.7 Ability to show animation of equipment.

.3 Custom Graphics:

.1 Created with use of commonly available graphics packages, such as PC Paint.

.2 Graphics generation package shall create and modify graphics that are saved in industry standard formats such as PCX, BMP, GIF, and JPEG.

.3 Graphics generation package shall also provide capability of capturing or converting graphics from other programs such as Designer, or AutoCAD.

.4 Graphics Library:

.1 Complete library of standard HVAC equipment such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators.

.2 Include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork.

.3 File format compatible with graphics generation package program.

.5 Engineering Units:

.1 Allow for selection of desired engineering units (i.e., SI) in system.

.2 Unit selection shall be able to be customized by locality to select desired units for each measurement.

.3 Engineering units on this project shall be SI.

.4 System Applications. Each workstation shall provide operator interface and offline storage of system information. Provide the following applications at each workstation:

.1 Automatic System Database Save and Restore:

.1 Store on hard disk copy of current database of each building controller.

.2 Database shall be updated whenever change is made in any panel in system.

.3 Storage of data shall be automatic and not require operator intervention.

.4 In the event of database loss in building management panel, first workstation to detect loss shall automatically restore database for that panel.

.2 Manual Database Save and Restore:

.1 System operator with proper password clearance shall be able to archive database from any system panel and store on magnetic media.

.2 Operator shall also be able to clear panel database and manually initiate download of specified database to any panel in system.

.3 System Configuration:

.1 Workstation software shall provide graphical method of configuring system.

.2 User with proper security shall be able to add new devices and assign modems to devices.

.3 This shall allow for future system changes or additions.

.4 Online Help:

.1 Context sensitive to assist operator in operation and editing of system.

.2 Available for all applications and shall provide relevant data for that particular screen.

.3 Additional help information shall be available through use of hypertext.

.5 Security:

.1 Each operator shall be required to log on to system with user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator.

.2 System supervisor shall have ability to set passwords and security levels for other operators.

.3 Each operator password shall be able to restrict operators' access for viewing and/or changing each system application, full screen editor, and object.

.4 Each operator shall automatically be logged off system if no keyboard or mouse activity is detected.

.5 Auto logoff time shall be set per operator password.

.6 System security data shall be stored in encrypted format.

.6 System Diagnostics:

.1 System shall automatically monitor operation of workstations, printers, modems, network connections, building management panels, and controllers.

.2 Failure of any device shall be annunciated to operator.

.7 Alarm Processing:

.1 Any object in system shall be configurable to alarm in and out of normal state.

.2 Operator shall be able to configure alarm limits, warning limits, states, and reactions for each object in system.

.3 Alarm Reactions:

.1 Operator shall be able to determine what actions, if any, are to be taken, by object (or point), during alarm.

.2 Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation, or displaying specific system graphics.

.3 Each of these actions shall be configurable by workstation and time of day.

.4 Object in alarm that has not been acknowledged within operator specified time period shall be rerouted to alternate operator specified alarm receipt device.

.4 Binary Alarms:

.1 Each binary object shall be set to alarm based on operator specified state.

.2 Capability to disable alarming when associated equipment is turned off or is being serviced.

.5 Analog Alarms:

.1 Each analog object shall have both high and low alarm limits and warning limits.

.2 Alarming must be able to be automatically and manually disabled.

.8 Trend Logs:

.1 Operator shall be able to define custom trend log for any data in system.

.2 This definition shall include interval, start-time, and stop-time. Trend intervals of 1, 5, 15, 30, and 60 minutes as well as once a shift (8 hours), once a day, once a week, and once a month shall be selectable.

.3 Trends shall start based on the hour. Each trend shall accommodate up to 64 system objects.

.4 System operator with proper password shall be able to determine how many samples are stored in each trend.

.5 Trend Data:

.1 Sampled and stored on building controller panel, and archived on hard disk.

.2 Able to be viewed and printed from operator interface software.

.3 Storable in tab delimited ASCII format for use by other industry standard word processing and spreadsheet packages.

.9 Alarm and Event Log:

.1 Operator shall be able to view logged system alarms and events from any location in system.

.2 Events shall be listed chronologically.

.3 Operator with proper security level may acknowledge and clear alarms.

.4 All that have not been cleared by operator shall be archived to hard disk on workstation.

.10 Object and Property Status and Control:

.1 Provide method for operator with proper password protection to view, and edit if applicable, status of any object and property in system.

.2 Statuses shall be available by menu, on graphics, or through custom programs.

.11 Clock Synchronization:

.1 Real time clocks in building control panels and workstations shall be synchronized on command of operator.

.2 System shall also be able to automatically synchronize system clocks daily from any operator-designated device in system.

.3 System shall automatically adjust for daylight savings and standard time, if applicable.

.12 Reports and Logs:

.1 Reporting package shall allow operator to select, modify, or create reports.

.2 Each report shall be definable as to data content, format, interval, and date.

.3 Report data shall be archived on hard disk for historical reporting.

.4 Ability for operator to obtain real time logs of designated lists of objects.

.5 Reports and logs shall be stored on PC hard disk in format that is readily accessible by other standard software applications, including spreadsheets and word processing.

.6 Reports and logs shall be readily printed to system printer.

.7 Operator shall be able to designate reports that shall be printed or stored to disk at selectable intervals.

.8 Custom Reports:

.1 Capable for operator to easily define any system data into daily, weekly, monthly, or annual report.

.2 Time and date stamped, and shall contain report title and name of facility.

.9 Standard Reports: The following standard system reports shall be provided. Reports shall be readily customized to Project by City personnel.

.1 Weather Data Report:

.1 Monthly report showing daily minimum, maximum, and average outdoor air temperature, and number of heating and cooling degree-days for each day.

.2 Annual (12 months) report showing minimum, maximum, and average outdoor air temperature for month, and number of heating and cooling degree days for each month.

.2 Tenant Override Reports:

.1 Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC and lighting services.

.2 Annual (12 months) report that shows override usage on monthly basis.

.3 ASHRAE Guideline 3Report: Daily report that shows operating condition of each chiller as required by ASHRAE Guideline 3. At minimum this report shall include:

.1 Chilled Water (or other fluid) inlet and outlet temperature.

.2 Chilled Water (or other fluid) flow.

.3 Chilled Water (or other fluid) inlet and outlet pressures.

.4 Evaporator refrigerant pressure and temperature.

.5 Condenser refrigerant pressure and liquid temperature.

.6 Condenser water inlet and outlet temperatures.

.7 Condenser water flow.

.8 Refrigerant levels.

.9 Oil pressure and temperature.

.10 Oil level (if applicable).

.11 Compressor refrigerant discharge temperature.

.12 Compressor refrigerant suction temperature.

.13 Manual entry field for addition of refrigerant.

.14 Manual entry field for addition of oil.

.15 Manual entry field for vibration levels.

.16 Motor amperes per phase.

.17 Motor volts per phase.

.18 PPM refrigerant monitor levels.

.19 Purge exhaust time or discharge count.

.20 Ambient temperatures (dry bulb and wet bulb).

.21 Date and time data logged.

.5 Workstation Applications Editor:

.1 General:

.1 Each PC workstation shall support full screen editing of system applications.

.2 Editor for each application at PC workstation.

.3 Applications shall be downloaded and executed at corresponding controller panels.

.4 Full screen editor for each type controller and application that shall allow operator with proper password to view and change configuration, name, control parameters, and system set points.

.2 Scheduling:

.1 Editor for scheduling application shall be provided at each workstation.

.2 Monthly calendar for each schedule.

.3 Exception schedules and holidays shall be shown clearly on calendar.

.4 Capable of allowing several related objects to follow a schedule.

.5 Advance and delay time for each object shall be adjustable from this master schedule.

.6 Operator with proper password level shall be able to modify schedule.

.7 Schedules shall be able to be easily copied between objects and/or dates.

.3 Equipment Coordination:

.1 Full screen editor shall allow equipment to be grouped for proper operation as specified in sequence of operations.

.2 Include coordination of Water Source Heat Pumps with their associated Outside air Supply Unit.

.4 Custom Application Programming:

.1 Provide tools to create, modify, and debug custom application programming.

.2 Operator shall be able to create, edit, and download custom programs at same time that other system applications are operating.

.3 System shall be fully operable while custom routines are edited, compiled, and downloaded.

.4 Programming language shall have the following features:

.1 English language oriented and based on syntax of programming languages such as BASIC. It shall allow for free form or fill in the blank programming. Alternatively, programming language can be graphically based using function blocks as long as blocks are available that directly provide functions listed below, and that custom or compound function blocks can be created.

.2 Full screen character editor/programming environment. Editor shall be cursor/mouse driven and allow user to insert, add, modify, and delete code from custom programming. It shall also incorporate word processing features such as cut/paste and find/replace.

.3 Allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.

.4 Editor/programming environment shall have debugging/simulation capability that allows user to step through program and to observe intermediate values and results. Debugger shall also provide error messages for syntax and execution errors.

.5 Support conditional statements (if/then/else/else-if) using compound Boolean (and, or, and not) and/or relations (equal, less than, greater than, not equal) comparisons.

.6 Support floating point arithmetic using the following operators: +, -, /, x, square root, and xy.

.7 The following mathematical functions shall also be provided: natural log, log, absolute value, and minimum/maximum value from a list of values.

.8 Predefined variables that represent clock time, day of week, and date. Variables that provide interval timing shall also be available. Language shall allow for computations using these values.

.9 Ability to predefined variables representing status and results of System Software, and shall be able to enable, disable, and change values of BACnet objects in system.

.6 Portable Operator's Terminal:

.1 Provide one capable of accessing system data.

.2 Ability to connect to any point on system network or directly to any controller for programming, setup, and troubleshooting.

.3 BACnet:

.1 Shall use Read (Initiate) and Write (Execute) Services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135, to communicate with BACnet objects in network.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.4 IBM compatible notebook-style PC, including software and hardware required. PC shall contain at minimum:

.1 1.6 GHz Intel Pentium Processor.

.2 512 MB RAM.

.3 80 GB Hard Drive.

.4 CD RW Drive.

.5 3 USB ports.

2.3 Networked DDC Controllers

.1 Controller Software:

.1 General:

.1 Provide applications software for building and energy management.

.2 Software applications shall reside and run in system controllers.

.3 Editing of applications shall occur at operator workstation.

.2 System Security:

.1 User access shall be secured using individual security passwords and user names.

.2 Passwords shall restrict user to only objects, applications, and system functions as assigned by system manager.

.3 User logon/logoff attempts shall be recorded.

.4 System shall protect itself from unauthorized use by automatically logging off following last keystroke. Delay time shall be user definable.

.3 Scheduling:

.1 General:

.1 Provide capability to schedule each object or group of objects in system.

.2 Each schedule shall include capability for start, stop, optimal start, optimal stop, and night economizer actions.

.3 Each schedule may consist of up to 10 events.

.4 When group of objects are scheduled together, provide capability to define advances and delays for each member.

.2 Weekly Schedule: Separate schedules for each day of the week.

.3 Exception Schedule:

.1 Ability for operator to designate any day of the year as an exception schedule.

.2 Shall override standard schedule for that day.

.3 May be defined up to a year in advance.

.4 Once executed, it will be discarded and replaced by standard schedule for that day of the week.

.4 Holiday Schedule:

.1 Capability for operator to define up to 99 special or holiday schedules.

.2 May be placed on scheduling calendar and repeated each year.

.3 Operator shall be able to define length of each holiday period.

.4 Alarm Reporting:

.1 Operator shall be able to determine action to be taken in event of alarm.

.2 Alarms shall be routed to appropriate workstations based on time and other conditions.

.3 Alarm shall be able to start programs, be logged in event log, printed, display custom messages or graphics.

.5 Remote Communications:

.1 Ability to dial out in event of alarm.

.2 Receivers shall include PC Workstations and alpha-numeric pagers.

.3 Alarm message shall include name of calling location, device that generated alarm, and alarm message itself.

.4 Operator shall be ably to remotely access and operate system using dial-up communications in same format and method used on Site under paragraph, Operator Interface.

.6 Maintenance Management: System shall monitor equipment status and generate maintenance messages based upon user designated run time, starts, and/or calendar date limits.

.7 PID Control:

.1 Algorithm with direct or reverse action, and anti-wind-up.

.2 Algorithm shall calculate time-varying analog value used to position output or stage series of outputs.

.3 Controlled variable, set point, and PID gains shall be user-selectable.

.4 Set point shall optionally be chosen to be reset schedule.

.8 Staggered Start: Shall prevent controlled equipment from simultaneously restarting after power outage. Order that equipment (or groups of equipment) is started, along with time delay between starts shall be user-selectable.

.9 System Calculations:

.1 Software to allow instantaneous power (e.g. kW), flow rates in L/s to be accumulated and converted to energy usage data.

.2 Algorithm shall calculate the following:

.1 Sliding-window kW demand value.

.2 Energy usage and weather data (heating and cooling degree days).

.3 Items shall all be available for daily, previous day, monthly and previous month.

.10 Anti-Short Cycling: Binary output points shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.

.2 Building Controllers:

.1 General:

.1 Performance:

.1 Provide adequate number of Building Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Manage global strategies described in Article Controller Software.

.3 Microprocessor based, capable of stand-alone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Building Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet:

.1 Building Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65 ^{o}C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50 ^{o}C.

.3 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If manufacturer does not provide keypad display, provide portable operator terminal.

.4 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.5 Memory: Building Controller shall maintain BIOS and programming information in event of power loss for at least 72 hours.

.6 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform orderly shutdown below 80 percent nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 metre (3 feet).

.7 Transformer: Power supply for Controller shall be rated at minimum of 125 percent of maximum power consumption, and shall be fused or current limiting type.

.3 Custom Application Controllers:

.1 General:

.1 Performance:

.1 Provide adequate number of Custom Application Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Shall manage local strategies described in Article Controller Software.

.3 Microprocessor based, capable of standalone operation, and shall continue to provide control functions without being connected to network.

.2 Sufficient memory to support its operating system, database, and programming requirements.

.3 Data shall be shared between networked Controllers.

.4 Operating system of Controller shall manage input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.

.5 Controllers that perform scheduling shall have real-time clock.

.6 Continually check status of its processor and memory circuits. If abnormal operation is detected, Controller shall:

.1 Assume predetermined failure mode.

.2 Generate alarm notification.

.7 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications:

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol.

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.2 Controller shall provide service communications port for connection to Portable Operator's Terminal using BACnet Data Link/Physical layer protocol.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.1 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65 ^{o}C.

.2 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50 ^{o}C.

.4 Keypad:

.1 Local keypad and display shall be provided for each controller.

.2 Provided for interrogating and editing data.

.3 Optional system security password shall be available to prevent unauthorized use of keypad and display.

.4 If manufacturer does not provide keypad display, provide portable operator terminal.

.5 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.6 Memory: Controller shall maintain BIOS and programming information in event of power loss for at least 72 hours.

.7 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform orderly shutdown below 80 percent nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 metre.

.8 Transformer: Power supply for Controller shall be rated at minimum of 125 percent of maximum power consumption, and shall be fused or current limiting type.

.4 Application Specific Controllers:

.1 General:

.1 Performance:

.1 Provide number of Application Specific Controllers to provide performance specified in Article System Performance and as indicated on Drawings.

.2 Microprocessor based, capable of standalone operation and shall continue to provide control functions without being connected to network.

.2 Contain sufficient I/O capacity to control target system.

.3 BACnet:

.1 Controller shall communicate with other BACnet objects on primary network using Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE 135.

.2 Objects supported shall include: Analog input, analog output, analog value, binary input, binary output, binary value, and device.

.2 Communications:

.1 Each Controller shall reside on secondary BACnet network using MS/TP EIA 485, Data Link/Physical layer protocol.

.2 Controller shall provide service communications port for connection to Portable Operators Terminal using BACnet Data Link/Physical layer protocol. Connection shall be extended to space temperature sensor where shown.

.3 Environment: Controller hardware shall be suitable for anticipated ambient conditions.

.4 Controller used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosure and shall be rated for operation at minus 40 to 65 ^{o}C.

.5 Controller used in conditioned ambient shall be mounted in dust-proof enclosure and shall be rated for operation at 0 to 50 ^{o}C.

.3 Serviceability: Provide diagnostic LEDs for power, communications, and processor. Wiring connections shall be made to field removable, modular terminal strips or to termination card connected by ribbon cable.

.4 Memory: Controller shall use nonvolatile memory and maintain BIOS and programming information in event of power loss.

.5 Immunity to Power and Noise:

.1 Controller shall be able to operate at 90 percent to 110 percent of nominal voltage rating and shall perform orderly shutdown below 80 percent nominal voltage.

.2 Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 watts at 1 metre.

.6 Transformer: Power supply for Controller shall be rated at minimum of 125 percent of maximum power consumption and shall be fused or current limiting type.

.5 Controller Input/Output Interface:

.1 Hard-wired inputs and outputs may tie into system through Building, Custom, or Application Specific Controllers.

.2 Protected such that shorting of point to itself, another point, or ground will cause no damage to Controller.

.3 Protected from voltage up to 24V of any duration, such that contact with this voltage will cause no damage to Controller.

.4 Binary Inputs:

.1 Shall allow monitoring of on/off signals from remote devices.

.2 Shall provide wetting current of at least 12 mA to be compatible with commonly available control devices.

.5 Pulse Accumulation Input Points: Conform to requirements of Binary Input points and accept up to 2 pulses per second for pulse accumulation, and shall be protected against effects of contact bounce and noise.

.6 Analog Inputs:

.1 Allow monitoring of low voltage (0-10 Vdc), current (4-20 mA), or resistance signals (thermistor, RTD).

.2 Compatible with and field configurable to commonly available sensing devices.

.7 Binary Outputs:

.1 Provide for on/off operation or pulsed low voltage signal for pulse width modulation control.

.2 Binary outputs on custom and building controllers shall have three-position (On/Off/Auto) override switches and status lights.

.3 Selectable for either normally-open or normally-closed operation.

.8 Analog Outputs:

.1 Shall provide a modulating signal for control of end devices.

.2 Shall provide either 0-10 Vdc or 4-20 mA signal as required to provide proper control of output device.

.3 Building or custom programmable controllers shall have status lights and two-position (auto/manual) switch and manually adjustable potentiometer for manual override.

3. EXECUTION

3.1 General

.1 Refer to Section 15900 - HVAC Instrumentation and Controls - General for requirements.

END OF SECTION

HVAC SYSTEMS TESTING, ADJUSTING, AND BALANCING

1. GENERAL

1.1 Submittals for Information Only

.1 The following is a list of standards which may be referenced in this section:

.1 AMCA: 203, Field Performance Measurement of Fan Systems.

.2 ASHRAE: HVAC Applications Handbook.

.3 AABC: National Standards for Field Management and Instrumentation Total System Balance.

.4 NEBB:

.1 Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

.2 Procedural Standards for Measuring Sound and Vibration.

.5 SMACNA: HVAC Testing, Adjusting, and Balancing Manual.

1.2 Submittals

.1 Informational Submittals:

.1 Documentation of experience record of testing authority.

.2 Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the work under this Contract.

.3 Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.

.4 Written verification of calibration of testing and balancing equipment.

.5 Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

1.3 Quality Assurance

.1 Air Balancing and Test Agency Qualifications:

.1 Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.

.2 Corporately and financially independent organization functioning as an unbiased testing authority.

.3 Professionally independent of manufacturers, Contractors, and Subcontractors of HVAC equipment being tested.

.4 Have a proven record of at least five similar projects.

.5 Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

2. PRODUCTS

2.1 Materials

.1 Provide materials, tools, test equipment, computers and instrumentation required to complete the work included.

.2 Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

.3 Drives for Belt-Driven Fans:

.1 Furnish cast iron or flanged steel sheaves.

.2 Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

3. EXECUTION

3.1 General

.1 Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

.2 Adjust and balance the following systems:

.1 Supply, return, exhaust and transfer air systems.

.2 Entire Condenser Water system including the entire cooling water side of the heat exchanger.

3.2 Adjusting And Balancing Air Systems.

.1 Preparation:

.1 Prior to beginning the Work, perform the following activities:

.1 Review shop drawings and installed system for adequate and accessible balancing devices and test points.

.2 Recommend to Contract Administrator dampers that need to be added or replaced in order to achieve a balanced system.

.3 Verify proper startup procedures have been completed on the system

.4 Verify controls installation is complete and system is in stable operation under automatic control.

.5 Verify test instruments have been calibrated to a recognized standard and are within manufacturer's recommended calibration interval before beginning the Work.

.2 General:

.1 When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.

.2 Lock and mark final positions of balancing dampers with permanent felt pen.

.3 Correct fan and airflow measurements for Site elevation.

.3 Equipment Data:

.1 Collect the following data and include in final report:

.1 Type of unit.

.2 Equipment identification number.

.3 Equipment nameplate data (including manufacturer, model, size, type, and serial number).

.4 Motor data (frame, kW, volts, FLA, rpm, and service factor).

.5 Sheave manufacturer, size, and bore.

.6 Belt size and number.

.7 Sheave centreline distance and adjustment limits.

.8 Starter and motor overload protection data.

.9 Include changes made during course of system balancing.

.4 Fan Systems:

.1 Measure fan system performance in accordance with AMCA 203.

.2 In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.

.3 Adjust Fan Air Volumes:

.1 Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.

.2 After final adjustments, do not operate motor above nameplate amperage on any phase.

.3 After final adjustments, do not operate fan above maximum rated speed.

.4 Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.

.5 Coordinate with the Contractor to provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower. Provide written notice to air handling unit Manufacturer and Contract Administrator if drive or belt changes were made. Belts and sheaves replaced during balancing for a different size will be returned to the Contractor.

.4 Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

.5 Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.

.6 Read and record motor amperage on all phases for each test condition.

.5 Air Outlets and Inlets:

.1 In each system at least one air path from fan to final branch duct termination shall have dampers fully open.

.2 Adjust air volumes on supply diffusers and grilles, and on return and exhaust grilles, to the quantity shown, with allowable variation of plus or minus 10 percent.

.3 Adjust diffusers and grilles for proper deflection, throw, and coverage. Eliminate drafts and noise where possible.

.4 After final adjustments are made secure dampers to prevent movement and mark final positions with permanent felt pen.

.6 Building Static Pressure:

.1 Measure building static pressure relative to outside in perimeter entrances during normal system conditions that would yield widest range in internal building pressure.

.2 Adjust building static pressure control parameters to ensure perimeter entrances are positive to outdoors by 12 Pa with entrance doors closed.

.3 Coordinate with the HVAC Control subcontractor to achieve positive building pressure in the Administration Area with respect to the DAF Process Gallery, DAF Influent Gallery and RW Pump Room. Simulate all extreme conditions including operating sanitary exhaust fan and fume hood exhaust fan simultaneously and demonstrate that the positive building pressure is sustained.

3.3 Adjusting And Balancing Water Side

.1 Preparation: Prior to beginning the Work, perform the following activities:

.1 Review shop drawings and installed system for adequate and accessible balancing devices and test ports.

.2 Recommend to Contract Administrator balancing devices needed to be added or replaced in order to achieve complete system balanced.

.3 Verify proper startup procedures have been completed on system.

.4 Verify controls installation is complete and system is in stable operation under automatic control.

.5 Verify hydronic systems have been filled and are clean. Examine a sample of strainers to ensure cleanliness.

.6 Verify manual air vents have been bled and expansion tanks and automatic air vents are functioning.

.7 Verify control valves and coil connections are complete and properly installed.

.2 General:

.1 When adjustments are made to a portion of a water system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.

.2 Throttling of butterfly and other nonbalancing device valves shall not be allowed.

.3 Lock and mark final positions of balancing devices with a centerpunch or permanent felt pen.

.3 Equipment Data:

.1 Collect the following data and include in final report:

.1 Type of pump.

.2 Equipment identification number.

.3 Equipment nameplate data (including manufacturer, model, size, type, impeller size and serial number).

.4 Pump capacity (flow rate and differential pressure).

.5 Drive data.

.6 Motor data (frame, kW, volts, FLA rpm, and service factor).

.7 Starter and motor overload protection data.

.8 Include changes made during course of system balancing.

.4 Pumps:

.1 Verify impeller size through a "dead-head" test. Do not perform on positive displacement pumps.

.2 Adjust water to achieve design flows at all modes of operation during single and multiple pump operation.

.3 Test redundant and stand-by pumps.

.4 After final adjustments, do not operate motor above nameplate amperage on any phase.

.5 Read and record pressures at pump inlet and discharge for each test condition.

.6 Read and record motor amperage on all phases for each test condition.

.7 Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.

.5 Terminal Flow Devices:

.1 Adjust water systems for required flow rates at each coil, connection, and terminal device.

.2 Provide proper flow through individual fin tube sections, evaporator and condenser circuits, each boiler loop, each pump, and recirculation loops.

.3 Measure and adjust flow through valves and valve bypass lines.

.4 Record and mark final position of balancing cocks, valves, and operators with a permanent felt pen or centerpunch.

.5 Read and record differential pressures across coils, control valves, boilers, and heat exchanges.

.6 Tolerances:

.1 Plus 10 percent to minus 10 percent.

3.4 Field Quality Control

.1 Equipment Performance Test:

.1 Gas Burner Heating Capacity Testing:

.1 Adjust system as required to achieve full output from burner.

.2 Read and record airflow capacity and inlet/outlet temperature.

.2 Heating or Sensible Cooling Coil Testing:

.1 Adjust system as required to achieve design flow conditions for both air and water sides of coil.

.2 Measure and record airflow rate, water flow rate, entering air temperature, entering water temperature, leaving air temperature and leaving water temperature.

.2 Balancing Log Report Requirements:

.1 Include narrative description for each system explaining TAB methodology and assumptions used. Clearly identify test conditions for tests performed. Include control setpoint.

.2 Log and record operational information from every test for each system, as necessary to accomplish services described.

.3 Include equipment data for units tested.

.4 Include reduced set of HVAC Drawings or system schematic diagrams with each element uniquely identified and indexed to balance log.

.5 Indicate recorded Site values, and velocity and mass correction factors used to provide equivalent standard air quantities.

.6 Include separate section in log, if necessary, describing operating difficulties in air or water systems that could not be eliminated by specified procedures. Identify these problems by system and location within building; include outline or summary of

condition and its effect on building, and describe corrective actions attempted and recommended.

.3 Quality Control Verification:

.1 After adjustments have been completed and balance logs submitted, balancing and testing agency shall be available to demonstrate the following:

.1 Air and water balancing procedures and verification of test results.

.2 Perform spot tests on a maximum of 20 percent of total diffusers and grilles, and on 10 percent of total water balance fittings, with measuring equipment used in original tests, at random points selected by Contract Administrator.

.3 Results of these spot tests shall agree with balance logs within plus or minus 10 percent. Where this accuracy cannot be verified, rebalance portions of system as requested by Contract Administrator.

.4 At completion of rebalance procedures, perform another spot test if required to verify results.

END OF SECTION

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

.1 Complete and operational electrical system as required by the Drawings and as herein specified.

1.2 Drawings and Specifications

.1 The intent of the Drawings and Specifications is to include all labour, products, and services necessary for complete Work, tested and ready for operation.

.2 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.

.3 Responsibility to determine which Division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

1.3 Quality Assurances

.1 Codes, Rules, Permits and Fees

.1 Comply with all rules of the Canadian Electrical Code, CSA Standard C22.1 and the applicable building codes. Do Underground Systems in accordance with CAN/CSA-C22.3 No. 7 except where specified otherwise.

.2 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

.2 Standard of Workmanship:

.1 Arrange and install products to fit properly into designated building spaces.

.2 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of Manufacturers.

1.4 Submittals

.1 See Section 01300 – Submittals.

1.5 Record Drawings

.1 Refer to Division 1.

1.6 Operation and Maintenance Manuals

.1 Refer to Section 01730 – Operation and Maintenance Manuals

1.7 Product Handling

.1 Use all means necessary to protect the products of this Division before, during and after installation and to protect products and installed work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.

.3 Remove advertising labels from all electrical equipment. Do not remove identification or certification labels.

.4 Remove dirt, rubbish, grease, etc. resulting from this Work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

2. PRODUCTS

2.1 Quality of Products

.1 All products provided shall be CSA Approved, ULC approved where applicable, unless otherwise specified.

.2 If products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.2 AREA CLASSIFICATION

.1 Unless otherwise indicated, supply equipment enclosures, boxes, electrical materials and products suitable for ambient environment of the following areas:

Area	Gen. Classification	Area Classification
Electrical and Mechanical Rooms	Dry, clean	CSA 1
Control Rooms	Dry, clean	CSA 1
DAF, Filter and Residuals areas	Wet	CSA 4

Area	Gen. Classification	Area Classification
Ozone Generating Room	Wet, Corrosive	CSA 4X
Chemicals Area	Dry, Dusty	CSA 4/4X
Work Shop / Maintenance Room	Dry, Dusty	CSA 12
Office and Administration Areas	Dry, clean	CSA 1
Outdoor Areas	Wet	CSA 3R, 4

2.3 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture for similar products throughout the Work.

2.4 Product Finishes

.1 Finish all cabinets, panelboards, switchboards, equipment cabinets, MCCs, etc. in ANSI 61 grey enamel unless otherwise specified.

.2 Apply primer on all items, which are to be finished on the job.

.3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

2.5 Use of Products during Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Contract Administrator and in accordance with the General Conditions, "USE OF PREMISES". Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

3. EXECUTION

3.1 Location of Outlets and Luminaires

.1 Electrical Drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural Drawings.

.2 Outlet and equipment locations shown on the Drawings are approximate. Locations may be revised up to 3 m to suit construction and equipment arrangements without additional cost to the City, provided that the Contractor is notified prior to the installation of the outlets, or equipment.

.3 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.

.4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of Manufacturers.

3.2 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and approved clips or hangers are used.

3.3 Equipment Identification

.1 3 mm thick plastic lamicoid name plates, black face, white core, mechanically attached with self tapping screws, 6 mm high lettering, to be attached to the front face of the following equipment:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.1 Distribution Centres (Indicate designation, bus capacity, voltage)

.2 MCCs (designation, voltage)

.3 Starters, contactors, disconnects (designation, voltage, load controlled)

.4 Panelboard (designation, voltage, bus capacity)

.5 Automatic transfer switch (designation, voltage, rating)

.6 Terminal cabinets and pull boxes (system, voltage)

.7 Transformers (designation, capacity, primary and secondary voltage)

.2 Color code exposed conduits (including conduits above T-bar ceilings), junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 m intervals. Color coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White
Fire Alarm System	Red	
Telephone	Lt. Green	
Building Alarm	Pink	
Intercom Systems	Purple	Green
Security Systems	Dk. Green	Lt. Brown
Door Intercom/Video	Purple	Yellow

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 Identify all conductors by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run, as per the Canadian Electrical Code.

.5 Conductors:

.1 Equipment Grounding – Green

.2 Neutral Conductor – White

Fire Alarm System	
Neutrals	White
Switch Legs	Phase Colour with White Tracer
Speaker Cct.	Blue with Yellow Tracer
Box Circuit	Black with Yellow Tracer
Annunciator	Brown with Yellow Tracer

.6 Place cable metal identification markers bearing the equipment tag number on all Teck cables on both ends and all locations where the cable leaves the cable tray or penetrates a concrete wall

.7 Install red plastic warning tape, 300 mm below grade, above all underground ducts.

.8 Provide permanent, corrosion resistant warning markers, suitable to the local inspection authority, imbedded in the surface of concrete slabs, which are directly above high voltage cables and duct banks.

3.4 Wiring to Equipment Supplied by Others

.1 City Supplied Equipment or equipment supplied under other Divisions will be moved to the installation Site by others. However, the electrical connection to the equipment shall be done by this Division unless noted otherwise.

3.5 Testing

.1 Refer to Section 16030 Electrical Testing and Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.6 Instructions to City's Personnel

.1 Refer to Section 16990 – Electrical Equipment and Systems Demonstration and Instruction.

3.7 Access Panels

.1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, supply access panels. Use panels of adequate size for servicing of the electrical Work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Contract Administrator.

.2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Use markers of a type approved by the Contract Administrator.

3.8 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

Receptacles in Mechanical Rooms and Process Areas	1000 mm
Receptacles and Telephone Outlets in offices and control rooms	300 mm
Light Switches	1400 mm
Fire Alarm Manual Stations	1400 mm
Fire Alarm Bells	2100 mm
Clocks	2100 mm
Television and Computer Outlets	300 mm
Intercom	1400 mm
Thermostats	1400 mm
Door Entry Push-Buttons	1400 mm
Wall-mounted speakers	2100 mm
Panelboards, starters, and disconnects (to top of cover)	2000 mm
End of Line Resistors	1800 mm
Outlets above Counters	175 mm above countertop or backsplash

3.9 Sealing of Wall and Floor Openings

.1 Seal all conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.

.2 Seal openings when all wiring entries shown on the Drawings have been completed.

.3 Sealing material fire resistant and not containing any compounds, which will chemically affect the wiring jacket or insulating material. Seal cable penetrations through fire separations.

3.10 Housekeeping Pads

.1 Mount all floor mounted electrical equipment installed by this Division on concrete housekeeping pads, which, unless otherwise noted, shall be the responsibility of this Division.

.2 Determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Contract Administrator within thirty days after the Contract Notice to Proceed.

3.11 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions and ceilings ensure the ends are flush with the finish on both sides, but for floors extend 100 mm above finished floor level.

.3 Fire stop opening with ULC approved assembly for the installation conditions. Mount lamacoid indicating assembly requirements by penetration. Include assembly details in O&M Manuals.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.12 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights required for electrical Work.

.2 Coordinate with Contractor for obtaining temporary power service.

.3 If City operations will be affected by any power outage required for this work, give adequate notice to the City and do not interrupt power until approval has been obtained.

.4 Give adequate notice to Contract Administrator of any power outage required for this Work. Schedule outages to provide least interference with other Work.

END OF SECTION

ELECTRICAL TESTING

1. GENERAL

1.1 Description

.1 This section specifies the testing requirements for the electrical work.

.2 Conduct and pay for all tests.

.3 Carry out tests in the presence of Contract Administrator. Provide instruments, meters, equipment and personnel required to conduct tests Performance Verification and prior to Total Performance.

.4 Unless otherwise specified, testing requirements apply to all electrical systems including:

.1 Power distribution system and grounding system

.2 Lighting and its control

.3 Motors, heaters and associated control equipment

.4 Security and communications systems

.5 Cable systems

1.2 Submittals

.1 Submit the following in accordance with Section 01300 – Submittals, Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment.

.1 Details of test procedures and listing of test instruments prior to proceeding.

.2 Test results on the specified forms and a report outlining the completed testing.

.3 Recommended periodic on-going testing requirements.

.4 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

.5 Copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

.6 Provide operation and maintenance data for incorporation into manual specified in Section 01730. Include values and settings of protective devices.

.7 Provide a collated, complete set of test records for each item of electrical equipment and interconnecting wiring. Include all relevant forms attached at the end of this section.

2. PRODUCTS

2.1 Not Used

3. EXECUTION

3.1 Readiness for Testing and General Requirements

.1 Prior to energization of any equipment and commencement of tests, visually check and verify that the following has been completed:

.1 The entire assembly is clean inside and outside. The cables are not lying loosely or hanging free.

.2 The equipment is adequately bonded and grounded with the ground wires installed clear of bus work.

.3 The phasing of all bus work and primary circuits is identified.

.4 All equipment is correctly identified (front and back, if applicable).

.5 Each starter is identified with correct drive number and drive title.

.6 All cables leaving electrical equipment have proper cable connectors, and are properly identified.

.7 All unused holes are adequately plugged.

.8 All unused wall and floor openings are sealed.

.9 Relay and metering sections of equipment enclosures are properly identified.

.10 Motors and connected units have been properly secured to the base, and aligned.

.11 Equipment nameplate data corresponds with characteristics of power supply.

.12 A single line diagram for the primary supply and feeder system is available in all electrical rooms.

.13 Emergency or stand-by lighting system is operational.

.14 The installation is in a safe condition, there are no unguarded live parts. Conduit seals are in place if a hazardous condition could occur during the testing phase.

3.2 Prefunctional Checkout

.1 Conduct functional testing in accordance with the requirements of Section 01670. Prior to functional testing, adjust and make operational all protective devices. Prior to energization of equipment, perform a functional checkout of the control circuit consisting of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. Submit a description of the proposed functional test procedures prior to the performance of functional checkout.

.2 Verify that motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.

3.3 Check-Out Tags

.1 Upon receipt of equipment attach a "Check-Out Tag" to each piece of equipment which has an equipment number assigned.

.2 On completion of each phase of the installation, enter the appropriate information on the tag. Include test results or make cross-reference to appropriate test form in the 'Remark' section.

.3 Tag: size 90 mm x 215 mm, yellow coloured tag stock with metal reinforced eye. A sample tag is shown on Form 16030-Y.

3.4 Coordination of Protective Devices

.1 The City will provide an overall coordination study of the electrical distribution system.

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are set to values and settings provided

3.5 Load Balance

.1 Measure phase current to panelboards, switchboards, and motor control centres with normal loads operating at time of acceptance. If load unbalance exceeds 15 percent, adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2 percent of rated voltage of equipment.

.3 Submit, at completion of work, a report listing phase and neutral currents on panelboards, switchboards, transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

3.6 Minimum Test Requirements

.1 The tests stipulated in this section are minimum requirements.

.2 Conduct additional tests recommended by equipment manufacturers or as deemed necessary by the Contract Administrator as construction progresses.

3.7 Insulation Resistance Measurements

.1 General

.1 Prior to energizing the equipment, conduct insulation resistance measurements on conductors and energized parts of electrical equipment. Minimum acceptable values of insulation resistance shall be in accordance with the applicable ICEA, EEMAC or ANSI standards for the equipment or material being tested, unless otherwise specified. Record the ambient temperature at which insulation resistance is measured on the test form.

.2 Record insulation resistance measurements on the appropriate forms. Insulation with resistance of less than 10 megohms is not acceptable.

.2 Test Instruments

.1 Unless otherwise specified, use the following insulation resistance testers (Megger):

.1 500 V instrument for circuits, feeders and equipment up to 350 V.

.2 1000 V instrument for 350-600 V circuits, feeders and equipment.

.3 Conductor and Cable Tests

.1 Measure the phase-to-ground insulation resistance for all circuits 120 volts and above except lighting circuits. Measurements may be made with motors and other equipment connected. Disconnect solid state equipment unless the equipment is normally tested by the manufacturer at voltages in excess of 1000 volts DC.

.2 Check phase rotation and identify each phase conductor of each feeder.

.3 Check each feeder for continuity, short circuits and grounds.

.4 After installing cable but before splicing and terminating, perform insulation resistance test on each phase conductor.

.5 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Replace entire length of cable if cable fails to meet any of test criteria.

.4 1 kV and 600 V Power Cables

.1 Refer also to MCC tests.

.5 25 & 5 kV Cables (before terminations are complete)

.1 Not Used

3.8 Transformers

.1 Completely factory test each transformer and certify results, proving the performance of the units to provide capacities as listed in these specifications.

.2 Submit manufacturer's certified tests as follows:

.1 Power distribution transformers: type tests, including optional type tests and routine tests, to CSA Standard CAN3-C88-M.

.2 Dry-type transformers: type tests and production tests to CSA Standard C9.

.3 Notify the Contract Administrator three (3) weeks in advance, in writing, of the time, date and place of the factory tests. The initial test may be attended by the Contract Administrator at the Contractor Administrator's expense. Any subsequent witness tests required to obtain acceptance shall be at the expense of the Contractor, but under the direction of the Contract Administrator. Include all costs applicable to witness testing.

.4 Witness tests may be waived in writing by the Engineer at his discretion; such waiver does not imply any acceptance by the Engineer nor limit the liability of the manufacturer and Contractor. Provide a copy of the test results 2 weeks prior to shipment of the transformers.

.5 After the transformers have been set in place, prior to energizing, conduct tests and record information listed in Forms 16030 E-G.

.6 Visually inspect enclosure, transformer core and coil bracing, terminal boards, tap changer, bushings and check all insulated surfaces for damage, foreign material and presence of moisture.

.7 Inspect all bolted HV and LV terminal connections and grounding connections for tightness.

.8 Test insulation resistance of transformer windings for at least one minute, using 1000 volt megger as follows:

.1 High voltage to ground with the low voltage windings connected to ground for the duration of the test.

.2 Low voltage to ground with neutral grounding resistor disconnected and high voltage windings connected to ground for the duration of the test.

.3 Dry out transformers known to have become wet or to have been subjected to unusually damp conditions, before placing in service regardless of the insulation resistance. Refer to Manufacturer's instructions for correct dry-out procedure.

.9 Test core for unintentional ground with ground strap removed, using 500 volt megger.

.10 Demonstrate correct indication and annunciation of winding temperature and sudden pressure devices at control panel.

.11 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions.

3.9 Circuit Breakers (All Voltages)

.1 Visually inspect all connections and assemblies and check all manual operations and physical interlocks on circuit breakers as specified.

.2 Check all electrical controls, including anti-pump and trip free operation.

.3 Check correct position indication.

.4 Verify trip settings from each protective device.

.5 Conduct tests and record information listed in Forms 16030-K and L.

3.10 Loadbreak Switches and Disconnects (All Voltages)

.1 Check all manual operations and physical interlocks.

.2 Check correct position indication.

3.11 Potential and Current Transformers (All Voltages)

.1 Verify winding ratio (nameplate rating).

.2 Verify terminal polarity.

.3 Check insulation resistance.

.4 Verify grounding connections.

.5 Conduct tests and record information listed in Forms 16030-O to Q.

3.12 Protective Relays

.1 Perform tests and conduct tests listed in forms 16030-R to T.

.2 Perform secondary current and/or potential injection on Site to verify to the Contract Administrator that protective relays trip as designed and set.

.3 After normal load has been added, complete a load test of protective relays with the given load; ensure that the correct amplitude and phasor quantities of current and voltage are read by relay.

3.13 Switchboard Metering

.1 Current and/or potential injection to verify correct scales and accuracies.

.2 Perform tests and results on form 16030-J.

3.14 Motor Control Centres and Circuits

.1 Conduct tests and record information listed in Form 16030-V.

.2 Verify continuity of wiring.

.3 Verify correctness of operation by operation of all controls, interlocks and automatic devices.

.4 In the cases of motor starters, make these tests with starter racked out and with control fuse removed, using a temporary "foreign" control supply.

.5 With the incoming feeder cable disconnected, with all feeder switches and motor starters racked in, with all feeder switches and motor starter contactors open and with ground detector and voltmeter fuses removed, Megger between phases and each phase to ground. Megger readings shall be 10 megohms or higher.

.6 With the load end of each cable connected to the load (motor etc.) and with the contactor or switch open, Megger the outgoing feeder cables and motor windings to ground by connecting the Megger to the load side terminals of the starter or switch. Test only one phase on motor starters, and all three phases on fused switch feeder units. Megger readings shall be 5 megohms or higher.

.7 Verify phase rotation.

.8 Visually inspect fuses and verify overload settings with motor nameplate data. Verify MCP settings.

3.15 Variable Frequency Drives

.1 Conduct tests and record information listed in Form 16030-Z and provide certification from the VFD manufacturer that the VFD equipment has been properly installed and tested.

.1 Verify continuity of wiring.

.2 Verify correctness of operation of all controls, interlocks.

.3 Adjust all setpoints, minimum frequency, maximum frequency, acceleration time, deceleration time, output current, constant speed, for each variable frequency drive based on the process requirements.

.4 Ensure moving and working parts are lubricated where required.

.5 Functional testing of each VFD system to applicable CSA and IEEE standards, with the motor connected.

.6 Confirm installation conforms to form 16030-V where applicable.

3.16 AC Motors

.1 Record and conduct tests listed in Form 16030-C.

.2 Check for proper lubrication.

.3 Check for direction of rotation, verify correct rotation.

.4 Check for vibration and excessive noise.

.5 Measure the insulation resistance of all motors before they are connected. Motors 50 hp and larger shall have their insulation resistance measured at the time of delivery as well as when they are connected. Insulation resistance values less than 10 megohms are not acceptable.

.6 With the incoming feeder cable disconnected, with all feeder switches and motor starters racked in, or connected, with all feeder switches and motor starter contactors open and with ground detector and voltmeter fuses removed, Megger between phases and each phase to ground. Megger readings shall be 10 megohms or higher.

.7 With the load end of each cable connected to the motor and with the contactor or switch open, Megger the outgoing feeder cables and motor windings to ground by connecting the Megger to the load side terminals. Test/record one phase on motor starters, all three phases on fused switch feeder units. Megger readings shall be 5 megohms or higher.

3.17 Power Factor Testing

.1 Not Used

3.18 Calibration and Verification

.1 Description

.1 Calibrate and verify the following equipment supplied under this Contract:

.1 600 V switchgear and panels

.2 Transformers

.3 MCCs

.4 VFDs

.5 LV Soft Starters

.6 UPS Equipment

.7 Electrical Monitoring Equipment

.2 Conduct the calibration and verification in the field after installation and connection of equipment, but prior to energization, in the presence of the Contract Administrator.

.3 Qualifications

.1 Perform the work by a firm specializing in, and with relevant experience in, testing H.V. and L.V. switchgear and protective relaying.

.4 Calibration and Verification

.1 Conduct the calibration and verification in the following stages:

.1 Power distribution transformers

.2 Secondary switchgear

.3 Motor control centres

.4 Variable frequency drives.

.2 Advise Contract Administrator well in advance when each stage is ready for the calibration and verification and:

.1 Ensure that all equipment is installed, connected and cleaned inside and out.

.2 Ensure that the specified tests have been carried out.

.3 The electrical rooms are clean and are adequately illuminated and heated.

.4 Provide 120V power for test purposes.

.5 Provide qualified personnel to assist in the calibration and verification.

.6 Provide all other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and overall coordination scheme. Field set each relay according to the recommended settings.

.4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer

and the Coordination/Short Circuit Study. Submit a written report on this verification to the Contract Administrator.

.5 Carry out the tests required of calibration and verification firm as specified in the other related sections.

.6 Ensure all bus and cable connections are tightened to manufacturer's specifications.

.7 Clean all relays with dry, dust-free compressed air.

3.19 Test Forms

.1 The forms listed below and included in this section are referenced from other sections of the specifications.

Form No.	Title
16030-A	Wire and Cable Resistance Test Data Form
16030-B	Cable Insulation Resistance Test Report
16030-C	Installed Motor Test Form
16030-D	D.C. Hypotential Test Report
16030-E	Dry Transformer Test Data Form
16030EE	Liquid Filled Transformer Test Form
16030-F	Transformer Insulation Resistance Test Report
16030-G	Transformer Turns Ratio Test Report
16030-I	Power Distribution Centre Test Form
16030-II	Power Distribution Centre Inspection Report
16030-J	Switchboard Metering Test Report
16030-K	Low Voltage Circuit Breaker Test Report
16030-L	Molded Case Breaker Test Report
16030-M	Medium Voltage Switchgear Test Form
16030-MM	Medium Voltage Load Interrupter Switch Test Form
16030-O	Current Transformer Test Report
16030-P	Instrument Transformer Test Report
16030-R	Protective Relay Test Form
16030-RR	Voltage Relay Test Report
16030-S	Overcurrent Relay Test Report
16030-T	Ground Fault Relay Test Report
16030-V	Motor Control Centre Test Report
16030-Y	Electrical Check-Out Tag
16030-Z	Installed VFD Test Form

END OF SECTION

16030-A. WIRE AND CABLE RESISTANCE TEST DATA FORM

Wire or Cable No.: _____ Temperature, °C_____

Location of Test	Insulation Resistance (megohms)
1.	
2.	
3.	
4.	
5.	
6.	
7.	

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-B. CABLE INSULATION RESISTANCE TEST REPORT

CLIENT:							REF. NO.:
LOCATION:							DATE:
APPROX. TEST TEMP.:				TEST VOLTAGE:			ENGR.:
CABLE IDENTIFICATION:	PHASE TO GROUND			PHASE TO PHASE			REMARKS:
	A	B	C	AB	BC	CA	
NOTES: .1 All readings in megohms unless otherwise noted.							

16030-C. INSTALLED MOTOR TEST FORM:

Motor Equipment Number _____ Date of test _____

Equipment Driven _____

MCC Location _____

Ambient temp _____ °C

Resistance:

Insulation resistance phase-to-ground megohms:

Phase A _____ , Phase B _____ , Phase C _____

Current at Full Load:

Phase _____ Current, _____ Amp
Phase _____ Current, _____ Amp
Phase _____ Current, _____ Amp

Thermal Overload Device: Manufacturer/catalog #_____ Amperes _____

Circuit breaker (MCP) setting: _____

Motor Nameplate Markings:

Mfr _____ Mfr Type _____ Frame _____ hp _____

Volts _____ Phase _____ RPM _____ **Service factor _____

Amps _____ Freq _____Hz Ambient temp rating _____ °C

Time rating _____ **Design letter _____
(EEMAC MG1-10.35) (EEMAC MG-1.16)

kVA Code letter _____ Insulation class _____

**Required for 3-phase squirrel cage induction motors only.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-D. D.C. HYPOTENTIAL TEST REPORT

CLIENT:		JOB NO.:	TEST NO.:
LOCATION:		DATE:	
SWITCHGEAR DESIGNATION:	FEEDER IDENTIFCATION:	ENGINEER:	

CABLE/SWITCHGEAR DATA

MANUFACTURER:	VOLTAGE RATING: _ KV ☐ GRD ☐ UNGRD	INSULATION:	CONDUCTOR SIZE:	CKT LENGTH
DATE INSTALLED:	TERMINATIONS LINE: _____ LOAD: _____			

TEST PROCEDURE

TEST TYPE: ☐ Acceptance ☐ Proof ☐ Maintenance	SPECIFICATION ☐ IPCEA S-_____ ☐_____

MAX TEXT VOLTAGE __ KV	VOLTAGE IMCREMENTS ___ KV	STABILIZATION TIME _____ Min.	CORONA SUPRESSION ☐ HV Sphere ☐ _____

SPACE CHARGE CONTAINMENT ☐ Polybag ☐ _____	SHIELD REMOVAL

GROUND PLANE ☐ Rubber Blanket ☐ _____	VOLTAGE SOURCE ☐ Stable ☐ Unstable ☐ _____

TEST DATA

AMBIENT TEMP °C	RELATIVE HUMIDITY %	TEST EQUIPMENT _____ kV Hipot Mfg. _____ Mod/Sn. _____

MEGGER TEST @ _____ VOLTS @ _____ MIN. | **SHIELD CONTINUITY TEST IN OHMS**

TEST	A-GND	B-GND	C-GND	A-B	B-C	C-A	A	B	C
Pre-Hipot									
Post-Hipot									

STEP VOLTAGE TEST					**ABSORPTION TEST**					**VOLTAGE DECREMENT TEST**				
VOLT	LEAKAGE CURRENT MICROAMPS				TIME	LEAKAGE CURRENT @__ KV MICROAMPS				TIME	DECAY VOLTAGE KILOVOLTS			
KV	PH.A	PH.B	PH.C	**	MIN.	PH.A	PH.B	PH.C	**	MIN.	PH.A	PH.B	PH.C	**

NOTES:

16030-E. DRY TRANSFORMER TEST DATA FORM:

Equipment No. _____ Temperature _____

Location _____

Winding: Primary _____ Secondary _____

A. INSULATION-RESISTANCE TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 1 minute.

			Test results (megohms)		
Voltage rating	Test voltage		Phase		Phase
0-600	1000	A-GRD	_____	A-B	_____
601-5000	2500	B-GRD	_____	B-C	_____
5000+	5000	C-GRD	_____	C-A	_____

Resistance readings less than the manufacturer's recommended value or less than 10 megohms shall be brought to the attention of the Construction Manager.

B. DIELECTRIC-ABSORPTION TEST:

The test shall be made with a megohmmeter at the test voltage for a period of 10 minutes.

1. TEST RESULTS: (Megohms)

	Phase		Phase
A-GRD	_____	A-B	_____
B-GRD	_____	B-C	_____
C-GRD	_____	C-A	_____

2. POLARIZATION INDEX:

$$\frac{\textit{10 minute reading}}{\textit{1 minute reading}} = \textit{polarization index}$$

(from paragraph "A" above)

	Phase		Phase
A-GRD	_____	A-B	_____
B-GRD	_____	B-C	_____
C-GRD	_____	C-A	_____

Polarization index values less than 2 shall be brought to the attention of the Construction Manager.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16000-EE. LIQUID-FILLED TRANSFORMER TEST FORM:

Equipment Number _____

Location _____

Date/Weather Conditions _____

A. Perform the "Insulation-Resistance Test" and "Dielectric Absorption Test" using Form 16000-E, Dry Transformer Test Data Form.

B. Perform an applied voltage (low frequency dielectric) test in accordance with ANSI C57.12.90, paragraph 10.5, Applied Voltage Test. Applied voltage levels shall be 75 percent of recommended factory test levels or recommended test levels of ANSI C57.12.00 Table 5.

C. Insulating oil shall be sampled and shall be laboratory tested for the following:

1. Dielectric strength.
2. Acid neutralization.
3. Interfacial tension.
4. Color.
5. Power factor.

D. Perform a turns ratio test between the windings for all tap positions.

E. The temperature and pressure switches shall be tested using a hot oil bath and air pump.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-F. TRANSFORMER INSULATION RESISTANCE TEST REPORT:

CLIENT	ETI JOB NO.	PAGE OF
LOCATION	ENGINEER	DATE

16030-G. TRANSFORMER TURNS RATIO TEST REPORT

CLIENT			ETI JOB NO.			
LOCATION			DATE			
TRANSFORMER DESIGNATION			ENGR.			
TRANSFORMER DATA						
MFGR.		MODEL		SERIAL NO.		
KVA	CLASS	PHASE	HERTZ	TEMP. RISE	IMPEDANCE __% AT __°C	INSULATION TYPE
HIGH SIDE KV Y ☐_☐	TAP CHANGER POSITION	AS-FOUND				
HIGH SIDE KV Y ☐_☐		AS-LEFT				
NEUTRAL						

TEST RESULTS

NON LOAD CHANGER - Tanke with LTC in "N" position

VOLTAGE	TAP	CALC. RATIO	H -H :X -X	H -H :X	H -H :X -X

LOAD TAP CHANGER - No Load Tap Changer in Position

VOLTAGE	TAP	H -H X -X	H -H X -X	H -H X -X	VOLTAGE	TAP	H -H X -X	H -H X -X	H -H X -X
	N					N			
	1L					1R			
	2L					2R			
	3L					3R			
	4L					4R			
	5L					5R			
	6L					6R			
	7L					7R			
	8L					8R			
	9L					9R			
	10L					10R			
	11L					11R			
	12L					12R			
	13L					13R			
	14L					14R			
	15L					15R			
	16L					16R			

TERTIARY WINDING - Taken with LTC in "N" Position

VOLTAGE	TAP	H -H :Y -Y	H -H :Y -Y	H -H :Y -Y

MEGGER READINGS

HIGH TO LOW AND GROUND	LOW TO HIGH AND GROUND	HIGH TO LOW
REMARKS:		

16030-I. POWER DISTRIBUTION CENTRE TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

   Phase: A ____ B ____ C____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	____	____	____	megohms
Across open pole	____	____	____	megohms
Pole to pole	AB___	BC___	CA___	megohms

3. Minimum pickup current shall be determined by primary current injection.

4. Long time delay shall be determined by primary injection at three hundred percent (300%) pickup current.

5. Short time pickup and time delay shall be determined by primary injection of current.

6. Instantaneous pickup current shall be determined by primary injection.

7. Trip unit reset characteristics shall be verified.

8. Auxiliary protective devices, such as ground fault or under voltage relays, shall be activated to ensure operation of shunt trip devices.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-II. POWER DISTRIBUTION CENTRE INSPECTION REPORT

CLIENT			JOB NO.		
LOCATION			DATE		
SWITCHGEAR DESIGNATION			ENGINEER		
NAME PLATE DATA					
MFGR.	S.D./STYLE NO.	U.L NO.	VOLTAGE	RATED CURRENT	INDOOR☐ OUTDOOR☐
MAIN PROTECTIVE DEVICE I.C. AMPS			MIN. PROTECTIVE DEVICE I.C. AMP		MAX. AVAILABLE FAULT CURRENT AMPS (SEE NOTE 21)
INSPECTION CHECK LIST					
CHECK POINT	*CONDITION	NOTES	CHECK POINT	*CONDITION	NOTES
BUS DATA: CU☐ AL☐	---		SWITCHBOARD CONDITION	---	
SIZE __ * _ * __ SQ. IN			SWITCHBOARD EXTERIOR		
BRACING			DOOR AND PANEL ALIGNMENT		
CLEARANCE OF BARE METAL			INDICATING LIGHTS		
GROUNDING:	---		SWITCHBOARD LIGHTS		
GND. ELECTRODE			DIRT AND DUST ACCUMULATION		
MAIN BONDING JUMPER			TIGHTNESS OF CONNECTORS		
EQUIPMENT GROUNDS			SWITCHBOARD GENERAL		
CONDUIT GROUNDS			HAZARDOUS LOCATION		
CABLE AND CONDUITS:	---		WORKING SPACE		
CONDUCTOR IDENTIFICATION			SEPARATE SOURCE INTERLOCK		
BRACING			ANCHORAGE		
INDUCTIVE HEATING			BREAKER - SWITCH		
UNUSED OPENGINS			GROUND FAULT PROTECTION		
CONDUIT BUSHINGS			MAINTENANCE ACCESSORIES		

FIELD DATA						
VOLTAGE MEASUREMENTS						
AN	BN	CN	AB	BC	CA	VOLTS
MEGGER TEST AT 1000 VDC						MEG
AG	BG	CG	AB	BC	CA	OHMS

NOTES

1. SLASHED ENTRY INDICATES AS FOUND AND AS LEFT CONDITIONS OR MEASUREMENTS

2. FAULT CURRENT CALCULATED USING THE $\frac{\textit{TRANSFORMER FULL LOAD CURRENT}}{\textit{TRANSFORMER IMPEDANCE}}$

*CONDITION A - ACCEPTABLE H - NEEDS REPAIR REPLACEMENT AND ADJUSTMENT NA - NOT APPLICABLE

16030-J. SWITCHBOARD METERING TEST REPORT

CUSTOMER:	LOCATION:	JOB NO.:
		DATE:
SWITCHGEAR DESIGNATION:	VOLTAGE:	TESTED BY:

VOLTMETERS AND AMMETERS

IDENTIFICATION	C.T./P.T. RATIO	FULL SCALE	SECONDARY INJECTION				REMARKS
			HALF SCALE		FULL SCALE		
			STANDARD	METER	STANDARD	METER	

REMARKS: .1 The indicated instrument transformers were primary injected to verify their proper ratio and connection.

16030-K. LOW VOLTAGE CIRCUIT BREAKER TEST REPORT

Client	Job No.							
Location	Date							
Switchgear	Feeder Identification	Engineer						
CIRCUIT BREAKER DATA								
Manufacturer	Type	Style/Serial Number		Frame Sz	Interrupting Rating			
Trip Unit/Sensor	Trip Unit Type	Characteristic Curve		Conductor Size/Phase				
Trip Unit Functions	Available Ranges	Settings						
		As Found		As Left				
		A	B	C	A	B	C	
Long Time								
Long Time								
Short Time								
Short Time								
Instantaneous								
Ground Fault								
Ground Fault								

INSPECTION					
Check Point	*Condition	Notes	Check Point	*Condition	Notes
Arc Chutes			Trip Latch		
Contact			Primary Stabs		
Contact			Control Contacts		
Contact Adjustment			Cell/Cradle Condition		
Electrical			Interlocks		
Trip Bar Adjustment			Operating Mechanism		

ELECTRICAL TESTS								
	As Found			As Left			Mfg. Tol. Min/Max.	Notes
	A	B	C	A	B	C		
Contact Resistance @ Amps in								
Long Time Pickup								
L T Delay @ % Rating (Amps)								
Short Time Pickup								
S T Delay @ % Rating (Amps)								
Instantaneous Pickup								
Ground Fault Pickup								
G F Delay @ Amps								
Shunt Trip Pickup			Undervolage PU					

Megger Test @___Volts	Breaker Closed						Breaker Open		
	A-GND	B-GND	C-GND	B-C	C-A	C-A	A	B	C

Notes

*Condition A-Acceptable R-Needs Rapair, Replacement, or Adjustment, C-Corrected NA-Not Acceptable

16030-L. MOLDED CASE BREAKER TEST REPORT – 400A and above

CUSTOMER:	LOCATION:	JOB NO.:
		DATE:
SWITCHGEAR DESIGNATION:	VOLTAGE:	TESTED BY:

BREAKER IDENTIFICATION	BREAKER			MILLIVOLT DROP @ RATED CURRENT			TRIP TIME IN SECONDS @ 300% RATED CURRENT			MFG. PUBLISHED TIME		INSTANTANEOUS TRIP (AMPS)				REMARKS
	RATING	MFG	TYPE	A	B	C	A	B	C	MIN.	MAX.	A	B	C	SET	

REMARKS:

NEMA MAXIMUM TRIP TIMES

BREAKER RATING	SECONDS
400 - 450 AMP	300
500 - 600 AMP	350
700 - 1200 AMP	600
1400 - 2500 AMP	750

16030-M. MEDIUM VOLTAGE SWITCHGEAR TEST FORM:

Equipment No. _____

Location _____

Room Temperature _____

The protective devices shall be set in accordance with the specification before the tests are performed.

1. Measure contact resistance (micro-ohms)

   Phase: A ____ B ____ C ____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C
Pole to ground	_____	_____	_____ megohms
Across open pole	_____	_____	_____ megohms
Pole to pole	AB__	BC__	CA__ megohms

3. Perform minimum pickup voltage tests on trip and close coils.

4. Verify the instrument transformer ratios. Check the transformer's polarity electrically.

5. The contactor shall be tripped by operation of each protective device.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-MM. MEDIUM VOLTAGE LOAD INTERRUPTER SWITCH TEST FORM:

Equipment Number _____

Location _____

Date _____

1. Measure contact resistance (micro-ohms)

   Phase: A ____ B ____ C ____

   Contacts shall be replaced if resistance exceeds 50 micro-ohms.

2. Perform an insulation resistance test (1000 volts DC for 1 minute).

Phase	A	B	C	
Pole to ground	_____	_____	_____	megohms
Across open pole	_____	_____	_____	megohms
Pole to pole	AB__	BC__	CA__	megohms

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

ELECTRICAL TESTING

16030-O. CURRENT TRANSFORMER

CUSTOMER:	LOCATION:	JOB NO.:
		DATE:
SWITCHGEAR DESIGNATION:		TESTED BY:

IDENTIFICATION	C.T. RATIO	POLARITY VERIFICATION	PRIMARY INJECTION TEST		MEASURED RATIO	SECONDARY INSTR. CONN.	REMARKS
			PRIMARY AMPS	SECONDARY AMPS			

REMARKS: .1 The indicated instrument transformers were primarily injected to verify their proper ratio and connection.

16030-P. INSTRUMENT TRANSFORMER TEST REPORT

CUSTOMER:		LOCATION:	JOB NO.:
SWITCHGEAR DESIGNATION:			DATE:
MFR:	TYPE/CLASS:	VA	TESTED BY:

IDENTIFICATION	TRANSFORMER RATIO	INJECTION TEST		MEASURED RATIO	POLARITY H__x	CIRCUIT CHECK	BURDEN VA	INSULATION TEST TO GROUND (MEGOHM)		
		PRIMARY	SECONDARY					PRIMARY	SECONDARY	CIRCUIT (500 V)

REMARKS:

16030-R. PROTECTIVE RELAY TEST FORM:

Location _____

Switchgear Breaker No. _____

Protective Relay Description _____

The protective relays shall be tested in the following manner:

1. Each protective relay circuit shall have its insulation resistance tested to ground.

2. Perform the following tests on the specified relay setting:

    a. Pickup parameters on each operating element.

    b. Timing test shall be performed at three points on the time dial curve.

    c. Pickup target and seal-in units.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-RR. VOLTAGE RELAY TEST REPORT

CUSTOMER:	LOCATION:	JOB NO.:
		DATE:
SWITCHGEAR DESIGNATION:	SYSTEM VOLTAGE:	TESTED BY:
RELAY NAMEPLATE DATA:		

RELAY DESCRIPTION			RELAY SETTINGS			RELAY TEST VALUES								
FEEDER	DEVICE/ PHASE	TYPE	TAP VOLTS	TIME DIAL		•PICK UP VOLTS	TIME DELAY TESTS (SECONDS)						TARGET OPER AMPS DC	INSUL TEST MEGOHMS
							@ __% P.U. VOLTS	MFG TOL.	@ __% P.U. VOLTS	MFG TOL.	@ __% P.U. VOLTS	MFG TOL.		
						/								
						/								
						/								
						/								
						/								
						/								
						/								
						/								

REMARKS:

• CODE IN PICK-UP COLUMN: TOP FIGURE IS "AS FOUND VALUE"

16030-S. OVERCURRENT RELAY TEST REPORT

CUSTOMER:	LOCATION:	JOB NO.:
		DATE:
SWITCHGEAR DESIGNATION:	SYSTEM VOLTAGE:	TESTED BY:
RELAY NAMEPLATE DATA:		

RELAY DESCRIPTION			RELAY SETTINGS			RELAY TEST VALUES									
FEEDER	DEVICE/ PHASE	C.T. RATIO	TAP VOLTS	TIME DIAL	INSTR	•PICK UP VOLTS	TIME DELAY TESTS (SECONDS)						•INST. AMPS	TARGET OPER. AMPS DC	INSUL. TEST MEGOHMS
							@ __% P.U. AMPS	MFG TOL.	@ __% P.U. AMPS	MFG TOL.	@ __% P.U. AMPS	MFG TOL.			
						/									
						/							/		
						/							/		
						/							/		
						/							/		
						/							/		
						/							/		
						/							/		
NOTES:															

CODE: IN COLUMS PICK-UP INST. AMPS: TOP FIGURE IS "AS FOUND VALUE"
BOTTOM FIGURE IS "AS LEFT VALUE"

16030-T GROUND FAULT RELAY TEST REPORT

CUSTOMER:	LOCATION:	JOB NO:
		DATE:
		TESTED BY:

SWITCHBOARD:	SYSTEM VOLTAGE:	NEUTRAL RESISTANCE TO GROUND:	SETTINGS SUPPLIED BY:

GROUND FAULT DESCRIPTION			RELAY RANGES		SETTINGS		TEST DATA								
FEEDER	MFR / TYPE	⊗TYPE OF SYSTEM	PICK-UP AMPS	TIME DELAY	⊙PICK-UP AMPS	⊙TIME DELAY	⊙PICK-UP AMPS	BREAKER REACTION TIME	TIME DELAY IN SECONDS				SHUNT TRIP PICKUP	TEST PANEL OPER.	NOTES
									_ @ _% PICKUP	MFG. TOL.	_ @ _% PICKUP	MFG. TOL.			

REMARKS:

16030-V. MOTOR CONTROL CENTER TEST FORM:

Equipment No. _____ Ambient room temperature _____

Location _____

A. MECHANICAL CHECK:

All bolted connections either bus to bus or cable to bus shall be torqued to the manufacturer's recommendations. Confirm the MCC is secured against seismic forces in compliance with the Canadian Building Code.

B. ELECTRICAL TESTS:

1. Measure insulation resistance of each bus section phase to phase and phase to ground for 1 minute using a megohmmeter at 1000 volts.

Test results (megohms)			
Phase		Phase	
A-GRD	_____	A-B	_____
B-GRD	_____	B-C	_____
C-GRD	_____	C-A	_____

2. Set the circuit breaker in the starter unit to comply with the requirements of driven equipment in compliance with the CEC.

3. Motor overload heater elements shall be sized and installed based on the actual nameplate full load amperes of the motor connected to the starter.

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

16030-Y. ELECTRICAL CHECK-OUT TAG

FRONT **REAR**

16030-Z. INSTALLED VFD TEST

VFD EQUIPMENT NO. _____ DATE OF TEST _____

DRIVEN MOTOR EQUIPMENT NO. _____

DRIVEN LOAD CHARACTERISTIC: CONSTANT TORQUE _____
VARIABLE TORQUE _____

SETPOINTS:
MINIMUM FREQUENCY _____ Hz

MAXIMUM FREQUENCY _____ Hz

ACCELERATION TIME _____Sec

DECELERATION TIME _____ Sec

SPEED RANGE: MANUAL ___ RPM, RPM
CDACS _____RPM, RPM

VFD CURRENT AT FULL LOAD: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR CURRENT: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR NAMEPLATE DATA:

MFR.: _____ MFR. TYPE _____ FRAME _____ hp _____
VOLTS: _____ PHASE _____ RPM _____ SERVICE FACTOR _____

AMPS _____ FREQ. _____ Hz AMBIENT TEMP. RATING _____ °C

TIME RATING _____ DESIGN LETTER _____

kVA CODE LETTER _____ INSULATION CLASS _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ Date _____
City's Representative

INSTALLATION OF CABLES IN TRENCHES AND IN DUCTS

1. GENERAL (NOT USED)

2. PRODUCTS

2.1 Cable Protection

.1 Provide 600 mm x 600 mm x 50 mm concrete patio blocks above direct buried cables. Patio blocks to be coloured RED for identification.

2.2 Markers

.1 Concrete type cable markers: [600 x 600 x 100] mm with words: "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Direct Burial of Cables

.1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.

.1 Make splices and terminations in accordance with Manufacturer's instructions using approved splicing kits.

.4 Underground cable splices not acceptable.

.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with Manufacturer's instructions.

.6 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings.

.7 After sand protective cover specified in Division 2 is in place, install continuous row of concrete patio as indicated to cover length of run.

3.2 Cable Installation in Ducts

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cable with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 Field Quality Control

.1 Perform tests in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test for cables under 1000 V.

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Pre-acceptance test for cables over 1000 V.

.1 NOT USED

.7 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.8 Acceptance Tests for cables over 1000 V

.1 NOT USED

.9 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.10 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of conduit and fittings for installation of wiring.

2. PRODUCTS

2.1 Rigid Steel Conduit

.1 Galvanized with threaded joints and connections.

.2 Connections in dry locations: steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222.

.3 Connectors subjected to moisture interior and exterior: liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series.

.4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 EMT Conduit

.1 Conduit: galvanized electrical metallic tubing.

.2 Fittings: steel rain-tite connectors with insulated throat. Steel rain tite couplings.

2.3 Rigid PVC Conduit

.1 Conduit: rigid non-metallic conduit of unplasticized PVC as manufactured C.G.E. "Sceptre" Schedule 40.

.2 Fittings: threaded male or female solvent weld connectors and solvent weld couplings, as supplied by conduit Manufacturer.

.3 Solvent: as recommended by conduit Manufacturer.

.4 Use rigid steel epoxy coated elbows where exiting the slab

2.4 Flexible Conduit (Open Air)

.1 Conduit: spiral wound, interlocking flexible metal conduit.

.2 Connectors: slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

2.5 Flexible Conduit (Embedded in Slab)

.1 Plastic conduit ENT may be used in the slab

.2 For conduit slab exit, use rigid steel, epoxy coated elbows

2.6 Liquid-Tight Flexible Conduit

.1 Conduit: flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

2.7 Rigid Aluminum Conduit

.1 Conduit: rigid extruded aluminum with threaded joints and connections and interior silicone coating to meet requirements of CSA C22.2 No. 45. Rigid metal conduit.

.2 Fittings: copper free cast aluminum conduit fittings for indoor and outdoor installations.

3. EXECUTION

3.1 Rigid Steel Conduit

.1 Use as raceways for following applications:

.1 In all areas exposed to weather.

.2 Locations where mechanical damage may occur and in mechanical rooms to a height of 1 metre.

.3 In hazardous classified areas.

3.2 EMT Conduit

.1 Use as raceways for following applications:

.1 For housing digital communications cables.

.2 In dry finished areas such as offices, and control rooms.

.2 It may not be used in any other areas.

.3 Include a separate ground wire in each conduit.

3.3 Rigid PVC Conduit

.1 Use as raceways for following applications

.1 In poured concrete floors and walls and on underground runs exterior to the buildings unless otherwise noted.

.2 Wiring installed in areas subject to intermittent or continuous moisture but not surface mounted.

.3 Category 2 locations.

.4 Do not surface mount rigid PVC conduit.

.2 Use strictly in accordance with the Canadian Electrical Code. Do not use in return air plenums and for exit and fire escape lights.

.3 Provide insulated ground wire in all rigid PVC conduits in accordance with the Canadian Electrical Code.

.4 Where rigid PVC conduit is set in poured concrete, solvent joints must be completed and allowed to set as per manufacturer's instructions. Tie PVC conduit securely to prevent movement and broken joints from concrete pour and vibration.

.5 Bend rigid conduit in strict accordance with Manufacturer's directions. Distorted bends will not be accepted.

3.4 Flexible Conduit

.1 Use as raceways for following applications:

.1 Connections to fhp motors in dry locations.

.2 Flexible connections to luminaries, in dry areas such as offices, control rooms and similar finished locations.

.2 Provide a separate insulated ground wire in all flexible conduits.

3.5 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

.1 At all motors, pipe mounted control devices, luminaries in non classified plant process areas, and other devices subject to movement or vibration in non classified process areas.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus 4 times the conduit diameter.

.3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.6 Aluminum Conduit

.1 Use as a raceway for the following applications and as indicated on Drawings.

.1 In wet areas for surface conduit runs.

.2 Surface mounted in tank areas and exterior.

.3 For all conduit systems that interconnect different plant areas such as Fire Alarm, Security System etc.

.4 Three phase motor wiring (Teck cable may also be used for this application where shown on the drawings).

.2 Follow Manufacturer's recommendations for cutting, threading, reaming and bending.

.3 Use thread compound to prevent thread damage and ensure watertight connections. Do not use red or white lead paint.

.4 Do not install in poured concrete.

3.7 Workmanship

.1 Install all conduit and wiring concealed, unless otherwise shown on the Drawings. Do not recess conduit in columns, except as noted, without permission from the Contract Administrator.

.2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two or more), space evenly, make bends concentric and mount on Unistrut racks.

.3 Lay out conduit to avoid interference with other work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.4 Slabs on grade: Install rigid PVC conduit in the gravel base below concrete slabs. Transition to rigid steel conduit around stub-ups through slab and extend 150 mm beyond concrete. When rigid steel conduit is installed in contact with earth, protect using Polykin #940 tape. Extend taping 300 mm above finished grade.

.5 Metal conduit installations in concrete pours: Tie down conduit to prevent shifting. Make all joints tight to ensure ground continuity. To prevent concrete entry, pack outlet boxes and cap conduit terminations both in boxes and stub-ups. Apply Polykin #940 tape to the conduit 152 mm both sides of the point of leaving slab.

.6 Do not place conduit in concrete slabs in which slab thickness is less than four times conduit diameter. Place conduits larger than this size under floor. Conduits to have minimum 25 mm concrete cover, or as shown.

.7 Organize conduit in slabs to minimize crossovers. Obtain approval and minimum concrete cover required as per Division 3 prior to installing conduits in slabs.

.8 At all recessed panels cap 2 to 25 mm and 4 to 19 mm empty conduits from panel into ceiling above and below for future use.

.9 Where conduit is installed in floor slabs to run up at equipment or motors, carefully check all conduit locations. Verify conduit locations for mechanical equipment from Shop Drawings or detail Drawings. Brace all stub-ups. For stub-ups, use rigid steel.

.10 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross section area at any point. Radii of bends shall be as per Canadian Electrical Code.

.11 For all runs of conduits, do not include more than equivalent of 4 - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Do not use pulling elbows, except by special permission.

.12 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.13 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.

.14 Use insulated non-metallic bushings on all conduit terminations.

.15 Ensure electrical continuity in all conduit systems.

.16 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.17 Install a 44 kg test line in all conduits left empty, including those in which others will pull cables, wires, etc.

.18 For conduits and ducts crossing building expansion joints, provide conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.

.19 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant. Seal all conduits entering or leaving hazardous classified areas with approved seals.

.20 Where conduits pass through walls, group and install through openings. After all conduits shown on the Drawings are installed, close wall openings with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Contract Administrator.

.21 Where Drawings show conduit designations, identify these conduits at each point of termination and at 50 m intervals with Thomas & Betts "Ty-Rap" No. TY532M labels.

.22 Where conduit finish is damaged, repair or replace.

.23 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.

.24 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter unless otherwise stated.

.25 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.

.26 Where panel board branch circuit conduits are amalgamated, do not exceed 25 mm diameter in size.

.27 Feed all conduit entries to motors, field devices, instruments, control stations, cabinets and panels in process areas from the side. Where this is not possible, permission must be obtained from the Contract Administrator for other means of entry. Maintain minimum 150 mm clearance above finished floor.

.28 Install sleeves and rough opening as required in advance of concrete pours.

.29 Sleeves shall extend 100 mm above floor or have concrete curbing to provide mechanical protection and water stop.

END OF SECTION

CABLE TRAYS

1. GENERAL

1.1 Description

.1 Provide a complete system of cable trays as shown on the drawings c/w all supports and hangers and seismic bracing necessary for the installation.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01300 – Submittals.

.2 Indicate various types of cabletroughs with terminology used in Part 2.

.3 Prior to construction, submit design drawings and calculations indicating all tray loading and seismic support designs have been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Cabletray

.1 All power trays shall be rigid aluminum ladder type, Class E to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as indicated on drawings

.2 All instrumentation and control trays to be rigid aluminum ventilated with 300 mm rung spacing, 150 mm side rails and width as indicated on drawings.

.3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Field fabricate only those fittings not available from manufacturer.

.4 Provide stainless steel or galvanized steel rod hanger clamps, rod hangers, wall mounting support brackets and all necessary accessories for complete installation.

.5 Barriers where different voltage systems or electrical systems are in the same cabletrough, or as indicated.

.6 Approved manufacturers: Pilgrim, Unitray, B-Line, Comtray, Canstrut, ElectroTray.

.7 Unless otherwise approved by the Contract Administrator, provide cable trays of the same manufacturer throughout the contract

2.2 Supports

.1 Provide galvanized hardened steel (HS) rod hangers, rod hanger clamps and accessories as required.

.2 Wall mounted support brackets: Provide Unistrut P1000 channels mounted vertically in concrete wall c/w mounting brackets sized to suit cable tray width and loading.

3. EXECUTION

3.1 Installation

.1 Suspend cable trays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000mm on centers. Fasten hangers to channels securely mounted to the structure and provide seismic restraint as required.

.2 Install trays and raceways generally as indicated on drawings. Coordinate this work with the other trades to ensure adequate horizontal and vertical clearances.

.3 Provide minimum vertical clearance above the trays as indicated on the drawings.

.4 Provide minimum 600 mm horizontal clearance on one side of cable tray throughout.

.5 All trays are shown diagrammatically on the drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions.

.6 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.

.7 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.

.8 Run trays parallel to building lines unless otherwise shown on the drawings. A tray in tunnel areas to run parallel with the ceiling lines as the floor is graded for drainage. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.

.9 When the ends on Unistrut type shelf brackets are below 2100 mm AFF in a walking area, cut flush with tray. Permanently cap the end of Unistruts, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.

.10 Use beam clamps to fasten support systems to structural steel. Do not weld, drill or cut structural steel without approval by the Contract Administrator.

.11 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.

.12 Extend a stranded #2/0 bare copper ground conductor the length of each power tray route, and solidly connect sections of tray runs to the ground bus of the electrical room. Connect ground conductor to tray every 15 meters with approved grounding clamps. Provide a #6 copper ground conductor in the instrumentation trays, or where instrumentation tray runs are parallel to power tray, bond instrumentation tray to power tray ground every 15 metres.

.13 Generally run cables of different voltage classes in separate trays. Where a common tray is shown on drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray manufacturer.

.14 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.

.15 Size cable trays as indicated on drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.

3.2 Cables in Cabletray

.1 Install cables individually.

.2 Lay cables into cabletray. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 5 m centers, with nylon ties.

.4 Identify cables with nameplates in accordance with Section 16010 - Electrical General Requirements.

.5 Mark power and communication runs in accordance with colour coding outlined in Section 16010 - Electrical General Requirements.

END OF SECTION

BUSWAYS

1. GENERAL

1.1 Description

.1 Provide a complete system of cable bus trays as shown on the drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01330 – Submittals.

.2 Indicate in detail exact routing of busways from the transformer secondary to the building and in relation to column lines and structural slabs and walls. Provide drop test results for each size of busway.

2. PRODUCTS

2.1 General

.1 Feeder cable bus to be complete system of shop fabricated interconnecting busways as indicated on drawings. Fabricate busways in 3048 mm lengths or in shorter lengths to suit field conditions or duct fittings.

.2 Full capacity neutral.

.3 Totally enclosed weatherproof in CSA Enclosure 3 housing.

.4 Line to line voltage drop not exceeding 1.5 V per 30 m at rated current with concentrated load at one end at any system power factor.

.5 Internal fire barriers at floor/wall penetrations complete with flanges.

2.2 Cable

.1 Copper, sized for the ratings indicated, silver flashed at all joints, and connection locations. Cable to be rated for 55°C rise over a maximum ambient of 40ºC, but insulation be rated for 105°C.

2.3 Ratings

.1 Cablebus to be rated 347/600V, three phase, four conductor with full capacity neutral, or 600 volt, three phase, three conductor as indicated on the drawings. Brace assembly to withstand 100 kA symmetrical three phase, 60 Hertz, short circuit at 600 volts. Ampere ratings of busway to be as indicated on drawings. If busway has different ampere rating when mounted vertically or horizontally, use the lower rating and provide same duct and bus bar size for horizontal and vertical installation. Busway minimum ratings must equal ratings indicated. Select busway design to reduce electrical impedance. Voltage

drops at 95% power factor to be in accordance with manufacturer's data sheets at the time of tender.

2.4 Ground

.1 Provide a continuous ground in all feeder distribution busway sections to provide low impedance ground path.

2.5 Fire Barriers

.1 At all locations where cablebus pass through fire retarding walls or floors, provide approved fire barriers sealing busway penetrations. Use non-tracking fire barrier material that will not absorb moisture.

2.6 Fittings

.1 Provide complete system of fittings for cablebus installation, including:

- Transformer tap-offs.
- Flanged throats for connection to switchboards.
- Tee and angle fittings, tap-off boxes, end caps, elbows, reducers and offsets.
- Special short busway lengths to suit field conditions.
- Joint fittings, splice plates and coverplates.
- End fittings.
- Busway clamp hanger frames.
- Expansion joints on vertical and horizontal busway runs at all locations to suit layout as recommended by manufacturer and where busway crosses building expansion joint.

2.7 Hangers and Supports

.1 Provide a complete system of hangers and supports, generally as indicated on drawings or required for installation shown. Use busway clamp hanger frames to clamp to busway. Provide light field welded angle iron brackets to transfer weight of busway to building structure. Use columns as shown on structural drawings to hold vertical supports across transformer yard. Spacing of supports to be as shown on drawings and as required by CSA Code. For vertical riser busways, provide brackets to transfer weight of busway to building structure at each support.

2.8 Finish

.1 Clean and de-scale all metal parts. Apply a zinc-chromate prime coat and two coats of spray enamel to exterior and interior surfaces as per Section 16010 - Electrical General Requirements. Use galvanized or corrosion resistant bolts for all bolted connections.

2.9 Main Service Feeder Cablebus

.1 Provide low impedance cable bus from transformer secondary throat connections to main secondary switchboard. Match busway flanges to transformer and switchboard flanges.

2.10 Approved Manufacturers

.1 Designed Systems Inc.

.2 MPHuskey.

3. EXECUTION

3.1 Installation

.1 Before manufacture, field measure all critical and non-standard lengths of busway. Do not scale from drawings. Install all off-sets, corners and elbows to suit job conditions.

.2 Provide all necessary miscellaneous fittings space hangers and brackets. Provide a complete system of independent support for all busway runs. Connect from supports to busway clamp hanger fittings. Space hangers in accordance with manufacturer's recommendation, maximum spacing 3 m.

.3 Torque bolts in accordance with manufacturer's recommendations. Record torques and advise Contract Administrator in writing. Re-torque all connections after no more than 6 months after energizing and report to Contract Administrator in writing.

.4 Cover busway with plastic envelope until building is clean and bus ready to be meggered and energized.

.5 Connect all busway sections in the presence of Contract Administrator and have readings approved before energizing.

.6 Provide lamicoid plate identification on outside of busway covers. Install identification plates wherever busways enter or leave an area, but do not duplicate identification, if identification at one location is sufficient. Show busway designation, voltage and source of feed:

.7 Provide one torque wrench and head to match each type of bolt used and turn over to the City.

.8 Locate expansion joints as shown on the drawings.

.9 Coordinate concrete curbed slots at all points the busways passed through floors.

.10 Install all fire barriers where required.

.11 Seismic restraint the entire busways system.

END OF SECTION

WIREWAYS AND AUXILIARY GUTTERS

1. GENERAL

1.1 Submittals for Information Only

.1 Submit product data in accordance with Section 01300 and 16010.

2. PRODUCTS

2.1 Wireways

.1 Sheet steel EEMAC Type 12 (or EEMAC 4 to suit location) with hinged cover to give uninterrupted access.

.2 Cross section dimensions: 63 x 63 mm, 101 x 101 mm and 152 x 152 mm, as applicable.

.3 Finish: baked grey enamel.

.4 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

.5 Compliance: JIC EMP-1.

.6 Acceptable manufacturers: Hammond, Hoffman, Pursely.

2.2 Surface Mounted Aluminum Raceways:

.1 AL5200 Dual-Channel Aluminum Raceway by Wiremold/Legrand.

.1 Material: Alloy 6063-T5 extruded aluminum; minimum thickness 0.050-inches.

.2 Finish: Satin, No. 204 clear anodized, 0.004-inch thick, Class R1 Mil-Spec.

.3 Device Cover Plates: Suitable to mount commercially available duplex devices, single 1.40-inch and 1.59-inch diameter receptacles. Cover plates shall be removable using standard screwdriver without marring the finish.

3. EXECUTION

3.1 Installation

.1 Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.

.1 Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.

.2 Electrical Security: Metal raceway shall be electrically continuous and bonded in accordance with the Canadian Electric Code for proper grounding.

.3 Raceway Support: Raceway shall be supported at intervals not exceeding 5 feet or in accordance with manufacturer's installation sheets.

.4 Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.

.5 Unused Openings: Close unused raceway openings using manufacturer's recommended accessories.

.2 Install wireways and auxiliary gutters as indicated on drawings.

.3 Keep number of elbows, offsets, connections to minimum.

.4 Install supports, elbows, tees, connectors, fittings.

.5 Install barriers where required.

.6 Install gutter to full length of equipment.

3.2 CLEANING AND PROTECTION

.1 Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.

.2 Protect raceways and boxes until acceptance.

END OF SECTION

COMMUNICATIONS CONDUCTORS

1. GENERAL

1.1 Acceptable Manufacturers, Contractor and Subcontractor Qualifications

.1 All products include cabling are to be by a single manufacturer, commercial grade. Unless otherwise stated.

.2 Acceptable manufacturer for riser and horizontal cabling and passive hardware components: NORDX/CDT. For all others equipment/hardware, refer to other sections and specific descriptions as noted.

.3 The Contractor or Subcontractor shall attach an up-to-date copy of the certification and proof of their CSV status from the manufacturer in their initial submittal.

.4 All personnel installing communications cabling must be trained and authorized by NORDX/CDT and Certified and shall have the authority to certify the cabling installation and materials for 25 years respectively to cover system applications and performance prior to start any work.

.5 Manufacturers' part numbers are for reference purpose only; it is the responsibility of the contractor to verify with the manufacture/distributors and the City exact component/devices, prior to purchase and installation.

1.2 Abbreviations

.1	AFF	Above Finish Floor
.2	ANSI	American National Standards Institute
.3	AST	American Society for Testing Materials
.4	BICSI	Building Industry Consulting Service International
.5	CSV	Certified System Vendor
.6	CSA	Canadian Standard Association
.7	CAT5	Category 5
.8	CAT5e	Category 5e
.9	EIA	Electronic Industries Alliance
.10	ELFEXT	Equal Level Far-end Crosstalk
.11	ETL	Electronic Testing Laboratories
.12	EMI	Electromagnetic Interference

.13	ER	Equipment Room
.14	FEXT	Far-end Crosstalk
.15	IEEE	Institute of Electrical and Electronic Engineers
.16	IDC	Insulation Displacement Connectors
.17	ISO	International Standard Organization
.18	I/O	Information Outlet
.19	MM	Multimode (Fiber)
.20	NEXT	Near-End Crosstalk
.21	OTDR	Optical Time Domain Reflectometer
.22	STP	Shielded Twisted Pair
.23	SM	Singlemode (Fiber)
.24	TR	Telecommunications Room
.25	TGB	Telecommunication Ground Bus
.26	TIA	Telecommunications Industry Association
.27	TMGB	Telecommunication Main Ground Bus
.28	PSNEXT	Power Sum Near-end Crosstalk
.29	PSELFEXT	Power Sum Equal Level Far-end Crosstalk
.30	UL	Underwriters Laboratories
.31	UTP	Unshielded Twisted Pair

1.3 General Requirements

.1 Conform to the current guidelines contained in the following for products, workmanship and installation:

.1 .ANSI/TIA/EIA-568-B.1, (or CAN/CSA T529) Commercial Building Telecommunications Cabling Standard. Part 1: General Requirements.

.2 .ANSI/TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard. Part 2: Balanced Twisted-Pair Cabling Components.

.3 ANSI/TIA/EIA-568-B.3, Commercial Building Telecommunications Cabling Standard. Part 3: Optical Fiber Cabling Components Standard

.4 ANSI/EIA/TIA-569 (or CAN/CSA T530-M), Commercial Building standard for Telecommunications pathways and spaces

.5 ANSI/EIA/TIA-606 (or CAN/CSA T528-M), Administration standard for Telecommunications infrastructure of commercial buildings.

.6 ANSI/EIA/TIA-607 (or CAN/CSA T527), Commercial Building Grounding and Bonding requirements for telecommunications.

.7 CAN/CSA C22.1 Canadian Electrical Code, Part 1 and all the Local Amendments.

.8 CAN/CSA C22.2 Canadian Electrical Code, Part 2.

.9 CAN/CSA C22.2 No. 232-M Optical Fiber Cables

.10 CSA Canadian Standards Association.

.11 CRTC Canadian Radio and Telecommunications Commission, standards and guidelines.

.12 TIA/EIA 455-160-A Fiber optic test Procedures

.13 CEC Canadian Electrical Code

.14 ISO 11801 Class D specifications

.15 National Building Code (NBC)

.16 IEEE 802.3 Ethernet Standards.

.17 Building Industry Consulting Service International (BICSI) TDMM Manual latest editions at the time of tender.

.18 NORDX/CDT Structured Cabling System.

1.4 Summary of the Work

.1 This section is responsible for the supply and installation of all cross-connect cables, GigaBIX and BIX mounts, GigaBIX and BIX connectors, ring, strips, outlets, jacks, faceplates.

.2 This section is responsible for the supply, installation and termination of all riser cabling, tie-wraps, labeling and testing.

.3 Provide materials for the installation of the structure communication cabling system, approved tools for the installation and test equipment and, labour for a complete operational system.

.4 Provide a minimum of 3-meter service loop of cables at the point at which the cable enters the room to provide future moves, additions and changes. Run the excess on the horizontal cable tray.

.5 For labeling and identification of the cables, conform to Section 16010.

.6 Supply, install and anchor all required termination frame mounts.

.7 Supply material and labor for the installation of fire stopping material affected by the communications cabling installation. Coordinate with Contractors and install in accordance with local and municipal codes and guidelines.

.8 Submittals/Shop drawings: Provide manufacturer catalogue information, part number, colour, configuration, etc. of the proposed equipment/devices to be installed on this project.

.9 Provide: test results, as-built (colour and black) drawings and deficiencies list corrected.

2. PRODUCTS

2.1 Copper Backbone Distribution \Cable

.1 Provide 25 pair NORDX/CDT UTP, Category 3, ATMM multipair solid conductors, between Area 30A OM&A Building and Area06A Secondary Pump House.

.2 Copper backbone cable: inner layer insulated with polyolefin, outer layer Polyvinyl Chloride material and covered with PVC jacket and overlaid with a corrugated coated aluminum shield.

.3 Terminate copper cable in Area06A Secondary Pump House onto BIX mounts and 25pr connectors. Provide 40 meters of cable slack in Area 30A OM&A Building for future connection under Contract 2S.

.4 Physical characteristics:

.1 Gauge #24AWG with a dark gray colour jacket.

.2 Insulation thickness: 0.015cm.

.3 Jacket thickness: 0.114cm: 100 pair.

.4 Overall cable diameter: 28mm.

.5 Specifications:

.1 Impedance: 102 ±15%.

.2 Maximum DC Resistance: 8.8 Ohm/100m

.3 Maximum DC Resistance Unbalance: 1.50%

.4 Maximum Capacitance Unbalance pair to ground: < or equal to 262pF/100m

.5 Mutual capacitance @ 1Khz: 5.15nF/100m.

.6 Copper riser cable: meet the following performance specifications:

Frequency (Mhz)	Attenuation DB/100m (328ft)	Worst pair to pair NEXT (dB)
0.772	2.2	43
1.0	2.6	41
4	5.6	32
8	8.5	28
10	9.7	26
16	13.1	23

2.2 Copper Data and Voice - Horizontal Cabling

.1 Utilize NORDX/CDT, 2400 Series, UTP, Cat6, and 4-pair Cables.

.2 For horizontal cabling, meet or exceed all mechanical requirements as per ANSI/ICEA S80-576 standards for plenum and non-plenum cabling installed within this buildings.

.3 Mark UTP cable with manufacturer name, sequential length, cable type and rating, conductor gauge, pair count, UL/CSA listing.

.4 For horizontal voice cable jacket, use blue color.

.5 Physical Characteristics:

.6 UTP, 4-pair, #24AWG, 100-Ohm characteristic impedance, channel 250MHz Power Sum Bandwidth, 4.8Gb/s Information Bit Rate, bare solid-copper conductors, thermoplastic insulated, enclosed in a CMR, UL Listed type CM or rated thermoplastic jacket and all individual conductors to be insulated with fluorinated ethylene propylene (FEP) to satisfy the CSA, FT4 fire rating. Unless otherwise specified.

.1 Cable Size: maximum O.D. 6.22mm plenum.

.2 Breaking strength: 41 kg at temperature of -20°C to 60°C without jacket or insulation cracking.

.3 Minimum bend radius: 24.8mm.

.7 Transmission Characteristics:

.1 DC resistance: less than 6.6Ω/100m with an unbalance between two conductors of any cable pair of 3% maximum.

.2 Mutual Capacitance of any one pair: maximum of 50 pF/m.

.3 Nominal velocity of propagation (NVP): 68% at 10Mhz, non-plenum.

.4 Use "cables" that meet or exceed Category 6 minimum (maximum) values based on worst pair measurements using 4 pair cables and components and the following "Permanent Link" performance standards specifications:

Parameters 100m (328Ft)	**Frequency**		
	100Mhz	**200Mhz**	**250Mhz**
Insertion Loss (Attenuation)	18.6dB	27.4dB	31.1dB
NEXT	41.8dB	36.9dB	35.3dB
Power Sum NEXT	39.3dB	34.3dB	32.7dB
ELFEXT	24.2dB	18.2dB	16.2dB
Power Sum ELFEXT	21.2dB	15.2dB	13.2dB
PSACR	20.7dB	6.9dB	1.6dB
Return Loss	14.0dB	11.0dB	10.0dB
Propagation Delay	538ns		536ns
Delay Skew	45ns		45ns

2.3 Communication Outlet – Recessed/Surface Wall and Floor

.1 Wall mounted faceplates: single gang, duplex, quad or six-ports modular faceplate that will house NORDX/CDT, 8-pin modules (RJ45) jacks for data and NORDX/CDT, 6-pin modules jack for voice. Always position data outlets on the top left side of the assembly.

.2 Surface outlet box minimum two ports, side entry cable. NORDX/CDT, colour: Almond.

.3 Faceplates/Adapters:

.1 NORDX/CDT, 4-port, MDVO, 106 adapter, almond colour. Part No. NXMAA4-02

.4 Outlets (back boxes) for telecommunications cabling: double configuration. Coordinated with Electrical design documents.

.5 Do not mount or install communications outlets on temporary, removable partitions, furniture, doors, etc.

.6 Provide all inserts, blank inserts, dust covers and necessary accessories to make system complete and operational.

.7 Coordinate with communications outlets, mounting, height and locations.

.8 Maintain and or replace as required existing Telecommunication stainless steel faceplates to accommodate and support a minimum of four ports telecommunication modular jacks and faceplate.

2.4 Communication Jack (Voice)

.1 NORDX/CDT UTP Category 6, 8-position/8 conductors module jacks (RJ45), T568-B Designation.

.2 Connector 3 layer lead frame technology, backward compatible to support Cat5, Cat5E and Category 6 latest cabling technology.

.3 50 micro-inch lubricated gold plating over 100 micro-inch Nickel under plate.

.4 Power Sum supports up to 622Mps ATM. To use with M series modular faceplates, frames or surface mount boxes.

.5 Insertion: minimum 750 cycles.

.6 NORDX/CDT, GigaFlex, PS6+ module, IDC 8 position, white color.

2.5 Termination Field

.1 Backbone (Voice) Termination

.2 Terminate all backbone copper cables in wall mounted NORDX/CDT 300pr Giga BIX mounts fully loaded with connectors distribution

2.6 Cross Connect Wire

.1 Provide and install cross-connect wires. Meet or exceed the same category rating of connecting hardware installed.

.2 UTP, Cat3, two (2) pair, cross connect wires for voice termination. Color: Blue-White.

2.7 Labeling:

.1 Label each horizontal outlet and all bix mounts as per City of Winnipeg standards.

.2 Coordinate labeling to be coordinated with the City.

.3 Label each horizontally terminated cable and punch down designation strip. Use same label scheme as above.

.4 Recommended software labeling: NORDX/CDT.

2.8 Miscellaneous

.1 Plywood Backboard

.2 Provide plywood backboard, complete with all cutouts for punch down BIX block termination assembly mounting frames.

.3 19mm thick x 1200mm wide x1200mm high long plywood backboards with one side good and two coat of insulation non-conductive fire retardant paint/varnish. Do not raise or expose screws or nails above finish surface.

.4 Coordinate mounting height and location with Contractors.

3. EXECUTION

3.1 General

.1 Supply, install, and test a complete system as per specification and drawings.

.2 Maintain open copper-conductor the following minimum clearances.

Items	Minimum Clearance
Fluorescent ballasts	450mm
Conduit and cables used for electrical distribution less than 1kV	450mm
Conduit and cables used for electrical distribution greater than 1kV	1000mm
Motor	1200mm
Transformer	1200mm
Pipes (gas, oil, water, etc.)	300mm
HVAC (equipment, ducts, etc.)	150mm

.3 Cable pathway shall cross perpendicular to fluorescent lighting and electrical power cables.

.4 Install cables in conduit and cable tray, etc. along or at right angles to building lines unless impractical to do so. Verify specific cases of deviation in advance with Contract Administrator.

.5 No more than two 90° bend in conduit run between pull points.

.6 Provide pull box for every 30m (100') of conduit run.

.7 All communication wall mounted outlet boxes to be single gang box. Coordinate with other electrical requirements.

.8 All conduits for voice outlets to be minimum of 19mm from outlet to raceway or ceiling space, unless noted otherwise. Coordinate with other electrical requirements.

.9 Do not expose backbone cables more than 1m (3ft). Use appropriate cable protection, like conduit and cable tray.

3.2 Installation

.1 Copper Cables

.1 Swab raceway system before installing wiring.

.2 Do not exceed manufacturer's maximum pulling force specifications.

.3 Provide a service loop of not less than 3m for future additions, moves and changes.

.4 Ensure that cable is not flattened, squeezed, or crimped at any point along entire run.

.5 No cable splices or intermediate terminations will be permitted.

.6 Bundle cables neatly into logical bundles with Mille-tie or Velcro tie-wrap only. Do not use non-fire rated plastic strip in the performance of the Work except at voice termination blocks.

.7 Label all horizontal cables and the outlets at both ends with identifications shown on the drawings. Make all labels permanent - NORDX/CDT.

.8 Label all termination blocks with the corresponding label of the cables. Supply all accessories to properly label the patch panels and termination blocks.

3.3 Connectors

.1 NORDX/CDT, 4 pair for horizontal termination and 25pr for backbone/riser termination.

.2 Utilize the proper BIX Termination Blocks tool for all horizontal (data/voice) copper termination and connections.

.3 Use connectors suitable for nature of conductor in cable, e.g. stranded vs. solid copper.

.4 Ensure that connectors' strain relief provisions are used. Strip jackets only amount allowed in ANSI/EIA/TIA standards.

.5 Maintain pair twists as close to connector as possible. Terminate the cable such that the each pair retains its twists within maximum of 12mm of the termination point.

.6 UTP 8-position configuration will be in accordance with T568B.1 and/or CAN/CSA-T529 standards.

3.4 Cross Connect Wires

.1 Coordinate and install cross-connect wires for all backbone and voice termination.

3.5 Boxes and Fittings

.1 Ensure in advance that outlet box/voice outlet installation methods yield vertically mounted voice outlets.

3.6 Grounding

.1 Conduct ground and testing of communications equipment in accordance with NORDX/CDT design and industry standards testing guidelines and as per local electrical safety code.

.2 Connect wall mounted grounding bus bar via an insulated, stranded copper wire of #6 AWG or larger diameter wire with appropriate termination hardwire.

.3 Use grounding connections that are less than 1Ω above the electrical entrance ground resistance.

.4 Adhere to the recommendations of the ANSI/TIA/EIA 607 standards.

3.7 Testing

.1 Test vertical backbone voices pairs for continuity, NEXT, cable impedance, length and pair mapping.

.2 Provide, in a Microsoft Excel for Window format on disk, tabulated results for every cable, Communications Room, cable label, length, polarity information, pair attenuation (db), induced noise (db), worse pair NEXT, wire map, impedance, ACR and indicated whether the cable has passed/failed.

3.8 Administration

.1 Labeling

.2 Provide labels and administration system as per standards recommendations, Manufacturer and City of Winnipeg Guidelines.

.3 Place a unique identifier on each connecting passive hardware component installed, like: backbone cables, horizontal cables, faceplates, etc.

.4 Label all components as per ANSI/TIA/EIA 606-A standards and as per manufacturer recommendations.

.5 Ensure labels are visible during and after the installation of the cabling infrastructure.

.6 Use labels resistant to the environment, such as moisture, heat, grease and ultraviolet light.

.7 Use labels that are printed or generated by a mechanical device. No hand written labels will be accepted.

.8 Ensure labels support linkages to others individual/groups of records, like "as-built" drawings that will allow a person to easily located and/or relate outlets, pathways spaces within a given area or telecommunications room.

3.9 Horizontal Cabling

.1 Label all (individual) horizontal cables within 150mm to 230mm from the cable ends.

.2 Labeling includes cables in each Telecommunication room, and work areas.

3.10 Backbone Cables

.1 Label all backbone cables at each end, and at 30 meter intervals indicating source and destination, number of pair/strands.

3.11 Outlets

.1 Label each data and voice outlet as per the following: floor of the building, Telecommunication room served from, patch panel or IDC section termination and sequential patch panel or section where the 4pr horizontal cable is terminated.

3.12 Test Results

.1 For test results, include all parameters listed in these specifications and as per latest manufacturer recommendations.

.2 Provide legible printed forms and on CD-ROM and on recognized computer software application, like Microsoft Excel. Results include, but are not limited to: cable reports, cross-connects and connecting hardware. Include any software tools to view and print any or all cable test reports.

.3 Provide documents for all test results and for all conductor pair strands of each cable.

.4 Generate reports from a computer-based, recognized program.

.5 Test recorded in the memory of the field tester shall be transferred into a windows ™ based database software, unaltered and "as saved in the tester".

3.13 Quality Assurance

.1 Ensure Subcontractor is fully certified to install the manufacturer products and have a minimum of three (3) years on the installation of systems of this type and size.

3.14 Warranty

.1 Provide a minimum two (2) years warranty, after Total Performance, on installation and workmanship to the City and separate of the manufacturer warranty.

END OF SECTION

SYSTEM CABLES

1. GENERAL

1.1 Submittals for Information Only

.1 Submit product data in accordance with Section 01300 and 16010.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CSA CAN3-C21.1, 600V Control Cable +75°C to -40°C.

.2 CSA CAN3-C22.1, Canadian Electrical Code.

1.3 Coordination

.1 Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to connecting equipment.

2. PRODUCTS

2.1 Twisted Pair Shielded Cables

.1 TPSH cables constructed as follows:

.1 2 copper conductors, stranded, tinned, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm. Conductor identification to be by black and white coloured insulation.

.2 Insulated for 600 V, 90°C.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded, tinned copper drain wire, minimum #18 AWG.

.5 Overall PVC jacket rated to -40°C and meeting low gas emission and FT 4 flame test requirements set forth in CSA-C22.2 - No. 0.3 and IEEE 383. Overall PVC jacket to be grey in colour.

.6 The entire cable assembly to be suitable for pulling in conduit. Cables located in cable tray to be armoured and jacket-type, unless specified otherwise.

.2 Individually shield and continuously number code each pair of multiconductor TPSH cables. Provide an overall shield and overall flame retardant PVC jacket for the cable assembly.

2.2 RTD and Multi Conductor Shielded Cable

.1 RTD cables constructed as follows:

.1 3 or more copper conductors, stranded, tinned minimum #18 AWG.

.2 PVC insulated for 600 V.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded, tinned copper drain wire.

.5 Overall flame retardant PVC jacket as specified for TPSH cables.

2.3 Teck Cables

.1 As per Section 16125 with the exception that instrument Teck cables are to be identified by a grey coloured outer jacket.

2.4 Wire

.1 As per Section 16125.

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH or instrument Teck cable for all low level analog signals such as 4-20 mA, 1-5VDC, 0-10VDC, pulse type circuits 24VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTD's and transmitters or CDACS RTD inputs.

3.2 Digital Signals

.1 Use TPSH cable for all input and output signals 24 VDC and under and terminate in the Marshalling Panels.

.2 Use Teck cable or wire and conduit for power to instruments, for 120 V signals other than those mentioned above and as otherwise shown.

3.3 Installation

.1 Install instrumentation cables in aluminum conduit systems or in cable trays (refer to Section 16114). Use a minimum of 300 mm length of liquid tight flexible conduit to connect the field sensors to conduit.

.2 Where instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

.3 At each end of the run leave sufficient cable for termination.

.4 Do not make splices in any of the instrumentation cable runs. Where splices are required, obtain the approval of the Contract Administrator prior to installing the cable. Do not splice cables to gas detection heads.

.5 Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes as indicated on the drawings, or as necessitated in the field. Keep splices in instrumentation cables separated physically from power circuits. Terminate cable shields on insulated terminals and carry through to the extent of the cable.

.6 Where splices are made to coaxial cables, use standard coaxial cable connectors.

.7 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

.8 Protect all conductors against moisture during and after installation.

3.4 Surface Installation for Teck Cables

.1 For Surface run cable install individual runs of teck cable or multiple runs, where as specified here.

.1 Fasten unistrut to the ceiling or wall as required.

.2 Secure cables to unistrut with cable clamps.

.3 Provide corrosion resistant clamps, hot dip galvanized, stainless steel or PVC coated.

.4 Install unistrut supports with a maximum spacing of one (1) metre.

3.5 Conductor Terminations

.1 Provide all equipment with terminal blocks to accept conductor connections. Refer to Section 17275.

.2 Equip instrumentation conductors terminated at equipment terminals other than terminal blocks with Burndy YAE-2 or STA-KON, self-insulated, locking type terminators. Size as required to fit conductors and screw terminals.

3.6 Testing

.1 Test all cables for isolation from ground and between conductors. Ensure resistance values are not less than those recommended by the cable manufacturer.

3.7 Fire Barriers

.1 Arrange for opening in fire rated walls and floors, where cables are to run through.

.2 Making good fire rating of floor or walls is by others.

3.8 Identification

.1 Identify all instrumentation cables as per Section 16010.

END OF SECTION

1. GENERAL

1.1 Submittals for Information Only

.1 Submit product data in accordance with Section 01300 and 16010.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 CSA C22.1; CSA CAN3-C21.1;

.2 IPCEA requirements where permissible.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Catalogue numbers specified are for the purpose of establishing the grade of quality of the materials specified in this section and are taken from one manufacturer's product line. Unless otherwise noted, products from other listed manufacturers which have identical features and characteristics are acceptable.

.2 Acceptable Manufacturers

.1 Cable Connectors

.1 Appleton Commander/Iberville

.2 OZ Gedney

.3 Thomas & Betts.

.2 Wire Connectors

.1 Burndy

.2 Thomas & Betts

.3 3M.

2.2 Building Wires

.1 Compliance: CSA C22.2 No. 38

.2 Conductors, unless otherwise shown or specified:

.1 Stranded copper.

.2 Minimum size No. 12 AWG, except No. 14 AWG for control circuits.

.3 Insulation chemically cross-linked, thermosetting polyethylene, and, unless otherwise specified, rated RW90, 1000 V. Use RWU 90 insulation where specified.

.4 Colour coding to Section 16010; wires sized No. 2 AWG and smaller to be factory-coded, taping will not be accepted.

2.3 Armoured Cable

.1 Conductors and insulation same as for Building Wires, except that manufacturer's standard insulation colour coding is acceptable.

.2 Multi-conductor or single-conductor construction as shown or specified, plus bare ground conductor.

.3 Armour interlocking aluminum.

.4 Colour coding of outer jacket to Section 16010.

.5 For ACWU type cable in stationary position, limited to MCC feeders, with the ampacity larger than 200A, copper may be substituted with ACM aluminum alloy.

.6 ACM aluminum alloy is not acceptable in underground installations.

.7 Teck Cable

.1 Compliance with CSA C22.2 - No. 0.3, No. 131 and No. 174.

.2 HL rating for hazardous location Zone 1 or 2, as shown.

.3 Inner jacket thermosetting PVC compound.

.4 Outer jacket of PVC material, rated -40°C and meeting low gas emission and FT 4 flame test requirements set forth in CSA C22.2 - No. 0.3 and IEEE 383.

.5 For Teck cable in stationary position, limited to MCC feeders, with the ampacity larger than 200A, the copper may be substituted with the ACM aluminum alloy.

.6 ACM aluminum alloy is not acceptable in underground installations.

.8 AC90 Cable

.1 Compliance with CSA C22.2 - No. 0.3 and No. 51.

.9 Fastenings and supports as for conduits specified in Section 16111; the following applies:

.1 Dry locations, as for RA conduit.

.2 Wet and outdoor locations, as for RPVC conduit.

.3 Corrosive locations, as for ERA conduit.

2.4 Tray Cable

.1 Not used

2.5 Flexible Cables

.1 Designations and Compliance

.1 Flexible Cords; Type S0W, to CSA C22.2 No. 49, Type ST, to CSA C22.2 No. 49.

.2 Portable Cables up to No. 2 AWG, Type SGOW, to CSA C22.2 No. 96.

.3 Portable Power Cables up to 500 KCM, Type G, to ICEA S-68-516.

.2 Conductors and Insulation

.1 Stranded

.2 Size as shown or specified

.3 Insulation and conductor arrangement as determined by governing standard.

2.6 Connectors for Armoured Cables

.1 Compliance: CSA C22.2 No. 18 and No. 174.

.2 Teck cable; watertight, dry-type not acceptable. Material compatible with connecting body such as junction, outlet or splice box to which connection is made. Grounding ring or "fingers" and neoprene bushing.

.3 Type AC cable; two-screw, clamp-type, nylon insulated, dry-type.

.4 Acceptable Products

.1 Hazardous locations, Thomas & Betts STAR TECK XP.

.2 Hazardous and corrosive locations, Thomas & Betts STAR TECK XP all with heat-shrink sleeve applied.

.3 Corrosive locations, Thomas & Betts STAR TECK, all with PVC coating.

.4 All other locations, for jacketted armoured cable, Thomas & Betts STAR TECK.

2.7 Strain Relief Connectors

.1 Watertight type for use with flexible cables.

.2 Material compatible with connecting body such as junction, outlet or splice box to which connection is made.

.3 Stainless steel wire mesh cord grip where connector is used with free-hanging cable.

.4 Acceptable Products: Thomas & Betts Type RANGER.

2.8 Wire Connectors

.1 The following listings specify products for copper conductors only. Aluminum conductors are not foreseen for this project. In the event that aluminum conductors are specifically approved by the Contract Administrator, it is the Contractor's responsibility to select the appropriate connector, using the following specifications as the guideline.

.2 Compliance: CSA C22.2 No. 65 and No. 188.

.3 Twist-On Connectors

.1 Insulated serrated or wing-type cap.

.2 Internal spiral spring; set-screw or crimp-type not acceptable.

.3 Minimum rating 600 V.

.4 Limited for use up to No. 10 AWG wire.

.4 Terminal Connectors

.1 Ring-type or locking fork-type, crimp-on terminal with nylon insulating sleeve over brazed seam shank.

.2 Minimum rating 600 V, 105°C.

.3 Conductive member made from electro tin-plated copper.

.4 Limited for use up to No. 10 AWG.

.5 Compression Lugs

.1 Made from one-piece pure electrolytic copper tubing, tin plated.

.2 Colour coded or marked with manufacturer's die index.

.3 Long barrel for minimum two crimps.

.4 For use with wires, No. 8 AWG and larger.

.5 Install ferrules with nylon insulating sleeves on all No. 14 and smaller stranded wires being terminated on terminal strips.

.6 Compression splices: similar to compression lugs, suitable for in-line, C-tap and similar configurations.

2.9 Joint Compound

.1 Conductive compound, suitable for application to threaded and compression connections.

.2 Compatible with cable and conductor insulation and material.

.3 Capable of being brushed on at temperatures from minus 25°C to 110°C.

.4 Acceptable products, within the limitations outlined:

.1 Aluma-Shield

.2 Burndy Penetrox

.3 Thomas & Betts Kopr-Shield.

2.10 Electrical Tape

.1 To be compatible with conductor or cable insulation or jacketting, as applicable.

.2 For general purpose: vinyl plastic, premium grade, minimum 0.18 mm (7 mil) thickness, black or colour coded, as required. Acceptable product: 3M Super 33 + or 35.

.3 Self-vulcanizing linerless rubber tape, minimum 0.76 mm (30 mil) thickness. Acceptable product: 3M Type 130 C.

3. EXECUTION

3.1 General

.1 Establish exact location of equipment and their connection points before wiring installation is commenced.

.2 Protect wiring against damage from welding spatter and other construction activity by suitable means.

.3 If available blockouts through slabs or walls are insufficient in size or location, enlarge, chip or drill additional openings in accordance with Divisions 3 and 4.

.4 Protect metallic cable connectors in process areas with heat-shrinkage sleeves. Sleeve length to extend 75 mm past the connector and to provide a tight fit around connector and cable.

.5 Do not use TC cable in areas classified as hazardous locations.

.6 Arrange wiring in process area such that motor connection boxes and other field mounted devices are entered at the side or bottom of the connection box or enclosure.

.7 Provide sufficient length of "free" cable for motors mounted on slide rails to permit the motor to travel the full length of the rails.

.8 Install reducing bushings where threaded entry in a motor connection box is larger than the hub size of the cable connector.

.9 In-line splices are not acceptable unless done in a junction or splice box.

.10 At the discretion of the Contract Administrator damage to a cable jacket may be repaired in accordance with the manufacturer's recommendation. If requested by Contract Administrator, replace the entire length of a damaged cable.

.11 Arrange cable supports such that maintenance work or removal of the equipment served by the cable, will not cause any damage to the cable.

3.2 Unscheduled Wiring

.1 To be installed in strict accordance with the CEC. Special attention to be given to conduit fill and ampacity derating where more than 3 conductors are present in a common conduit.

3.3 Building Wire

.1 Install in conduits to Sections 16106 and 16111.

.2 Install in wireways to Section 16116.

.3 Use No. 10 AWG conductors for 120 V homeruns over 30 m in length.

3.4 Jacketted Armoured Cable

.1 Install in cabletrays to Section 16114.

.2 Install on surface to Section 16111 and as further specified in this section.

.3 Install underground and in conduit to Section 16106.

.4 Unless installed in cabletray, group three or more cables running parallel to each other on a framing channel.

.5 Install cable connectors at both ends of each armoured cable.

.6 Armoured cables not installed on cabletrays but which pass through slabs and walls must be installed in sleeves, with one sleeve provided for each cable. Seal voids around cable with 'Duct Seal'. Where a fire rating is to be maintained - installation of Fire Stop materials is by others.

.7 Provide protection for cables where subject to mechanical damage, notably where cable passes through a floor slab.

3.5 Surface Installation for Teck Cables

.1 Install individual runs of teck cable or multiple runs, where specified as specified here.

.2 Fasten unistrut to the ceiling or wall as required.

.3 Secure cables to unistrut with cable clamps.

.4 Provide corrosion resistant clamps, hot dip galvanized, stainless steel or PVC coated.

.5 Install unistrut supports with a maximum spacing of one (1) metre.

.6 One or two surface mounted cables may be strapped using one hole straps and stand-off spacers. Use fastening, strapping and support materials that are compatible with the area conditions.

.7 Install three or more cables in 100 mm or larger cable tray.

3.6 Non-Jacketted Armoured Cable

.1 Restricted for use with branch wiring for lighting fixtures in accessible ceiling spaces. Maximum length of cable not to exceed 1.5 m; if branch wiring exceeds this distance, use Teck cable or conduit and wire.

3.7 Flexible Cables

.1 Must be installed with strain relief-type connectors to take the tension from the cable termination.

.2 Provide wire mesh grip where cable is free hanging or subject to frequent flexing.

.3 Where excess cabling is to be provided, neatly coil and tie excess length and attach to structure using hooks or supports as specified.

3.8 Connector Sizing

.1 Strictly adhere to manufacturer's listing for matching connector and terminal sizes to cable and conductor sizes.

.2 Similarly, select the proper compression tools and dies for each compression fitting to obtain the correct compression strength and as not to damage insulation sleeves and finishes.

.3 Select cable connectors with correctly sized grommets, bushings, glanding devices and threads. The application of tape or using reducers is not an acceptable alternative to selecting the correct size connector.

3.9 Terminations and Splices

.1 Twist-on connectors limited for use on lighting circuits, utility and control wiring in outlet boxes, luminaries, and with factory-supplied leads or pig-tails in field devices. Pre-twist conductors tightly prior to installation of twist-on connectors.

.2 Do not use twist-on connectors inside panels and apparatus which are equipped with terminal blocks.

.3 Use locking fork-type connectors on flat screw-type terminals.

.4 Use ring-type connectors up to No. 10 AWG on stud and post-type terminals and any termination subject to vibration.

.5 Use compression-type lugs for No. 8 AWG and larger unless equipment is provided with proper lugs designed for conductor terminations.

.6 Unless motor connection boxes are equipped with terminals, use compression-type motor connection lugs and machine bolts at motors for conductors up to No. 1 AWG. For larger conductors use two-hole compression lugs; apply self-vulcanizing tape or heat-shrink end cap over termination.

.7 In moist or corrosive areas, apply joint compound to conductor prior to installation of compression fitting.

.8 Exercise care in stripping insulation from wire. Do not nick conductors.

.9 Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

3.10 Fire Barriers

.1 Arrange for opening in fire rated walls and floors, where cables are to run through.

.2 Making good fire rating of floor or walls will be done by others.

3.11 Identification

.1 To Section 16010.

3.12 Testing

.1 To Section 16030.

END OF SECTION

SPLITTERS, JUNCTION BOXES, PULL BOXES AND CABINETS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and product data for cabinets in accordance with Section 01300 Submittals and Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

.1 Cast steel, Crouse Hinds, WBJ Series.

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

.3 For junction boxes mounted in exterior walls, provide complete with box vapour barriers.

2.3 Junction Boxes in Hazardous Classified Areas

.1 Junction boxes in hazardous classified areas to be rated and marked for hazardous classification of location in which they are to be installed.

2.4 Junction Boxes , Process and Wet Locations

.1 Junction boxes in Process and Wet locations are to surface mounted, continuous hinge NEMA 4X rated enclosures Hammond Mfg. 1414N4PH series or Contract Administrator approved equal.

.2 Provide Terminal Blocks for all wiring to Junction Boxes in Process areas. Include 20% spare terminals in each Junction Box.

2.5 Cabinets

.1 Materials:

.1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.

.2 Locks: to match panelboards.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.

.3 Install metal divider in cabinets with more than one voltage.

.4 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys 19 mm.

2.6 Splitters

.1 Not Used

3. EXECUTION

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the drawings or required for the installation.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code, as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items. Securely fasten backboards to cabinet interiors.

.2 Install terminal block where indicated.

.3 Splitters

.1 Not Used

.4 Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

.1 CSA C22.1-Canadian Electrical Code, Part 1.

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

.1 Surface or recessed concealed type: Die formed steel, hot dip galvanized, 1.25 oz/sq. ft. minimum zinc coating.

.2 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two coats finish.

.2 Components:

.1 Ceiling outlets, surface mounting, concealed:

.1 101 mm square, depth 54 mm, Iberville 52171 series

.2 119 mm square, depth 54 mm, Iberville 72171 series

.2 Ceiling outlets, concealed mounting in concrete:

.1 101 mm octagonal concrete rings, depth from 38 mm to 152 mm Iberville 54521 series.

.2 Extension ring to change from recessed conduit to exposed conduit, 101 mm octagonal, 38 mm deep square Iberville 53151-1/2 or 38 mm deep octagonal Iberville 51151C or 54 mm deep, Iberville 55171C.

.3 Wall boxes, concealed in concrete or masonry: for one and two gang applications: 101 mm square, 54 mm deep, 52171 series complete with suitable 52-C-49 series square cornered raised tile wall cover for proper device and wall surface application. Masonry boxes may be used for line voltage switching.

.4 Wall outlets, concealed non-masonry construction, with plaster finish: For one or two gangs used with switches, receptacles, etc., use 54 mm deep Iberville 52171 series, with matching plaster covers, depth to suit. Alternately, use 119 mm square boxes, Iberville 72171 series and covers as required. (For more than two gangs use solid boxes Iberville GSB series with GBC series cover, or special boxes as required).

.5 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.

.6 Floor Outlets, concealed: Of a type adjustable after box secured, permanently watertight concrete type, sheet steel, T & B #1963.

.7 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.3 Outlet Boxes for Rigid PVC Conduit

.1 Materials:

.1 Rigid PVC boxes and fittings: Unplasticized PVC.

.2 Components:

.1 Floor boxes: Round with threaded hubs for threaded female connectors.

2.4 Masonry Boxes

.1 Electro-galvanized steel masonry single and multi-gang boxes for devices flush mounted in exposed block walls.

2.5 Concrete Boxes

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.6 Conduit Boxes

.1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.7 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

3. EXECUTION

3.1 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.5 Install all outlets flush and surface mounted as required for the installation.

.6 Surface mount above suspended ceilings, or in unfinished areas.

.7 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Use plaster rings to correct depth. Use 30 mm on concrete block.

.10 Do not use sectional boxes.

.11 Provide boxes sized as required by the Canadian Electrical Code.

.12 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.13 Outlets installed in party walls to be offset by a minimum of one stud space.

.14 Provide ceiling outlet boxes for every surface mounted fixture or row of fixtures installed on suspended "hard" ceilings.

.15 Primary bushings in termination box for cable connection.

.16 Secondary bushings in termination box for bus duct connection.

.17 Control junction box.

.18 Stainless steel nameplate and connection diagram.

.19 Identify all boxes in accordance with Section 16010 – Electrical General Requirements.

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Work Included

.1 Provide and connect all wiring devices for the complete installation.

2. PRODUCTS

2.1 Manufacturer

.1 Wiring devices to be of one manufacture throughout the Work.

.2 Manufacturers shall be Hubbell, Smith and Stone, Bryant or Pass & Seymour.

2.2 Devices

.1 The catalogue numbers shown below are for the particular Manufacturer's series and all necessary suffixes shall be added for the requirements as stated. For all devices, use the specification grade minimum, and wherever possible, use devices of the same manufacture.

.2 Devices to be ivory with stainless steel coverplates in all but mechanical and process areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices. Use watertight twist-lock devices and cover plates for equipment in process areas.

2.3 Switches

.1 120 V, 20 A, single and double pole, three and four-way: As Hubbell No. 1221, 1222, 1223 and 1224.

.2 For wet locations use the following switches: 20 A, 120 V single pole ivory, and side wired press-switch, as Hubbell #1281.

.3 Provide manually - operated general purpose AC switches with the following features:

.1 Terminal holes approved by AWG #10 wire.

.2 Silver alloy contacts.

.3 Urea or melamine molding for parts subject to carbon tracking.

.4 Suitable for back and/or side wiring.

2.4 Receptacles

.1 Duplex 20 A, 120 V, 3 wire, ivory, U-ground, as Hubbell No. 6252, with the following features:

.1 Ivory urea molded housing.

.2 Suitable for #10 AWG for back and side wiring.

.3 Eight back wired entrances, four side wiring screws.

.4 Break-off links for use as split receptacles.

.5 Triple wipe contacts and rivetted grounding contacts

.6 Dual 15/20 A configuration.

.2 Duplex 15 A, 120 V, 3 wire, ivory, U-ground ground fault receptacle, as Hubbell No. GF-52621A.

.3 Single 15 A, 120 V, 3 wire clock receptacle with stainless steel plate, as Hubbell No. 5235.

.4 Single 30 A, 250 Vt, 4 wire receptacle with stainless steel cover, as Hubbell No. 9430.

.5 Single 50 A, 250 V, 4 wire range receptacle with stainless steel cover, as Hubbell No. 9450.

.6 Floor outlets, as Smith and Stone VIP Series or Odessey Controls Modular System c/w frames, as required, and receptacles and outlets, as indicated.

2.5 Coverplates

.1 Provide coverplates for all wiring devices, including but not limited to receptacles, telephone, computer, and television.

.2 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.3 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.4 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.5 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

.6 Use gasketted DS cast covers on FS and FD type boxes.

2.6 DAF and Filter Process Area Equipment Wiring Devices

.1 For DAF Area Flocculators and Filter Gallery Motorized Valves provide 600V 3Ø watertight devices including:

.1 Switched Safety Enclosure Hubble Catalog # HBLMITL

.2 Watertight Safety Shroud Receptacle Hubble Catalog # HBL2740SW

.3 Watertight Safety Shroud Twist-lock Plug Hubble Catalog # HBL2741SW

3. EXECUTION

3.1 Installation

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on drawings.

.4 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.

.5 Protect cover plate finish with paper or plastic film until all painting and other work is finished, then remove paper.

.6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.

.8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Contract Administrator at the Site. The dimensions given in Section 16010 – Electrical General Requirements shall be used as a guide, but is subject to final verification prior to installation.

.10 Supply and install a separate neutral conductor from branch circuit panel to devices for all dimmer control circuits

.11 Install watertight receptacles on guardrails as per drawings. Supply and install 4c#12 SOW cord and associated strain relief connectors as required for connection of equipment (length of cable to allow for connection of the equipment and minimize tripping hazard to personnel).

END OF SECTION

WIRE AND BOX CONNECTORS 0 - 1000 V

1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 Special Codes

.1 Install and rate power cables in accordance with the Canadian Electrical Code requirements or in accordance with IPCEA requirements where permissible.

1.3 References

.1 CSA C22.2 No. 65 Wire Connectors.

.2 EEMAC 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 A Maximum Rating).

2. PRODUCTS

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.

.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded or solid round copper conductors.

.2 Clamp for stranded copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper bar.

.5 Bolts for aluminum bar.

.6 Sized for conductors as indicated.

.4 Clamps or connectors for Teck cable and flexible conduit, as required.

2.2 Wire Connectors

.1 Use 3M "Scotchlock", self-insulated connectors for hand twist wire joints for lighting, small power, and control wiring.

.2 Use T & B non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten - 32 x 3/8" machine bolts.

.3 Terminate conductors #8 AWG and larger with Thomas & Betts Colour-Keyed compression connectors Series 54000, or on lugs provided with equipment.

.4 Thomas & Betts "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

.4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

.1 Select hand twist connectors for wire size and install tightly on conductors.

.2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the Manufacturer.

.3 Install compression connectors using methods and tools recommended by Manufacturer.

.4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

CONNECTORS AND TERMINATIONS

1. GENERAL

1.1 Inspection

.1 Obtain inspection certificate of compliance covering high voltage stress coning (if applicable) and include it with As-Built Drawings and maintenance manuals.

1.2 Product Data

.1 Submit product data sheets in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Connectors and Terminations

.1 Copper 2 hole long barrel compression connectors as required and sized for conductors.

.2 Contact aid for aluminum cables where applicable.

3. EXECUTION

3.1 Installation

.1 Install stress cones, terminations, and splices in accordance with the Manufacturer's instructions.

.2 Bond and ground as required.

END OF SECTION

GROUNDING

1. GENERAL

1.1 Description

.1 Supply and install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code and the local Electrical Inspection Branch.

.2 The system to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Ensure measured resistance to ground of the network does not exceed 3 ohms.

.3 Run all above ground grounding conductors in conduit or in Cable Trays as per drawings.

2. PRODUCTS

.1 Cables 3/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Braze connections for cables larger than 3/0.

.2 All ground wires: stranded copper TWH complete with a green jacket, except in transformer yard where bare copper horizontal wire shall be used, unless otherwise shown.

.3 Ground rods: 20 mm x 10000 mm copper clad steel. Rods to be surrounded with 50 mm of Bentinite or similar material to increase to contact area of the rod with the ground to 100 mm dia.

.4 Cable to pipe connectors: made with Burndy GAR connectors.

.5 In the main power distribution cabinet, provide a copper ground bar complete with lugs suitable to terminate all ground cables.

3. EXECUTION

3.1 Grounding - General

.1 Ground all frames and metallic enclosures of all electrical equipment and electrically operated equipment through the conduit system via a ground wire.

.2 Ground all transformers, switchgear, panel boards and splitters fed from the main distribution centre by grounding conductors sized in accordance with the Canadian Electrical Code. Terminate the ground wire at each end with an appropriate grounding lug and connect to the equipment ground bus. Ground wire to be green TWH.

.3 Ground all sub panels such as lighting panels, local distribution panels, etc. with a green ground wire run back to the panel from which it is fed. Size the ground conductor according to the Canadian Electrical Code.

.4 Connect using #3/0 bare copper conductors from the main power distribution and control cabinet ground bus to the ground ring. Test the system for ground resistance and install additional ground rods as necessary to meet a minimum requirements of 3 ohms.

.5 Ensure all main distribution centres, switchgear, and all panels requiring equipment grounds contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.6 Ensure all bolted connections are accessible.

.7 Ground all motors by means of an adequately sized green ground wire contained within the feeder conduit.

.8 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, Canadian Electrical Code.

.9 Bond expansion joints and telescoping sections of raceways using jumper cables as per Canadian Electrical Code.

.10 Use Burndy compression connectors for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium".

.11 Connect all transformer neutrals to the main ground bus using bolted connections.

.12 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.13 Provide conduit installed buried in earth or installed in or under grade floor slabs with separate ground wire installed, whether the conduits are metal or not.

.14 Ground all utility services to the electrical system ground.

.15 Ground all metal fences and gates

.16 Selected ground rods shall be accessible with ground wells as shown on Drawings

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and install all hangers, supports and inserts for the installation shown on the Drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

.1 Intermediate duty supporting structures: Aluminum strut channel together with the manufactures connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures: fabricated from welded steel structural members and hot dipped galvanized before installation.

.3 Nuts, bolts, machine screws: stainless steel.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. Epoxy adhesive type.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of 4.

.3 Manufacturer: Hilti (Canada) Limited.

2.3 Non-Metallic Anchors

.1 Material: Plastic anchors for sheet metal screws.

.2 Manufacturer: Fischer.

2.4 Conduit Supports

.1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two-hole straps indoors.

.2 Structural Steel: Crouse-Hinds “Wedgetite” supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".

.6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

.1 General: As per conduit supports, except that for single conductor cables, use suitable non-ferrous, or approved stainless steel or aluminum clamps.

3. EXECUTION

3.1 General

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Contract Administrator is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with Manufacturer's installation recommendations.

.6 Provide conduit rack with 25% spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Secure equipment to tile and plaster surfaces with lead anchors.

.2 Secure equipment to poured concrete and concrete masonry with adhesive anchors.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.5 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.

.2 Two-hole steel straps for conduits and cables larger than 50 mm.

.3 Beam clamps to secure conduit to exposed steel work.

.6 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support two or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.

.7 Use plastic anchors for light loads only. Use metal anchors for all other loads.

.8 Shot driven pins may only be used with written approval of the Contract Administrator.

.9 Use round or pan head screws for fastening straps, boxes, etc.

.10 Do not support heavy loads from the bottom chord of open web steel joists.

.11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four 6 mm fasteners.

.12 For surface mounting of two or more conduits use channels at 1.5 m oc spacing.

.13 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.15 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

END OF SECTION

DISTRIBUTION TRANSFORMERS - LIQUID COOLED

1. DESCRIPTION

1.1 Description

.1 Provide transformers to transform primary 4160 volt, 3 phase, 3 wire supply to main secondary distribution voltage of 600 volt, 3 phase, 3 wire.

.2 Use transformers that are suitable for operation in parallel.

1.2 Codes and Standards

.1 The transformers are to be built to CSA Specifications CAN/CSA-C2.

.2 EEMAC L9-3, interchangeability of HV bushings on pole-type distribution transformers.

1.3 Source Quality Control

.1 Submit production test certificates to Engineer.

1.4 Tests

.1 Conduct tests in accordance with Sections 16010 – Electrical General Requirements and 16980 – Testing, Adjusting, and Balancing of Electrical Equipment and System.

.2 Completely factory test each transformer and the results certified, proving the performance of the units to provide capacities as listed in these Specifications.

.3 Factory tests for each transformer to include:

.1 Resistance measurements of all windings

.2 Ratio test at rated connection and on all taps

.3 Polarity and phase relation tests

.4 Audible sound level tests

.5 No-load loss at rated voltage and losses at 25%, 50%, 75%, and 100% load

.6 Exciting current at rated voltage

.7 Laboratory test of insulating liquid

.8 Impedance

.9 Applied potential test

.10 Induced potential test

.11 95 kV B.I.L. test

.12 Hi-pot test

.13 Heat run, temperature rise tests on each transformer

The above heat run tests and impulse tests to be witnessed by the Contract Admininstrator.

.4 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20°C:

.1 High voltage to ground with secondary grounded for duration of test

.2 Low voltage to ground with primary grounded for duration of test

.3 High to low voltage.

.5 Inspect primary and secondary connections for tightness and for signs of overheating.

.6 Inspect and clean bushings and insulators.

.7 Check oil level and temperature indicators.

.8 Set transformer taps to rated voltage as specified.

.9 Inspect for oil leaks and excessive rusting.

.10 Inspect for oil level.

.11 Check fuses for correctness of type and size.

.12 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

.13 Notify the Engineer three weeks in advance, in writing, of the time, date, and place of the tests. This test will be attended first by the Engineer and the City at the City's expense. Any subsequent witness tests, due to any reason whatsoever, shall be at the expense of the equipment manufacturer, but at the direction of the Engineer.

.14 Witness tests may be waived by the Engineer at his discretion; such waiver shall be in writing and shall not imply any acceptance by the Engineer nor limit the liability of the manufacturer. A copy of the test results is to accompany the transformer when shipped.

1.5 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Dimensioned positions of mounting devices.

.2 Dimensioned positions of terminations.

.3 Internal and external component layout on assembly drawing.

.4 Insulating liquid capacity.

.3 At completion of work and prior to final acceptance, provide maintenance manuals for all items specified in this section, in accordance with Section 01730 – Operations and Maintenance Manuals.

1.6 Maintenance Data

.1 Provide maintenance data for liquid cooled transformers for incorporation into manual specified in Section 01730 – Operations and Maintenance Manuals and Section 16010 – Electrical General Requirements.

.2 Include insulating liquid maintenance data.

1.7 Maintenance Materials

.1 Provide any specialty tools or maintenance materials required for proper maintenance of transformers.

1.8 Delivery and Storage

.1 Ship transformers complete with first fill of liquid.

2. PRODUCTS

2.1 Manufacturer

.1 Primary and secondary terminals on opposite sides.

2.2 25kV Transformer Characteristics

.1 Not Used

2.3 5kV Transformer Characteristics

.1 Transformers: To CSA C2.

.2 Liquid cooled, outdoor, distribution transformers type ONAN with provision for fan cooling.

.3 Primary Voltage: 4160 V, 60 Hz, delta connected, 3 phase, 3 wire suitable for delta-wye connection,

.4 Secondary Voltage: 600 V, wye connected, 3 phase, 4 wire, grounded neutral suitable for delta-wye connection.

.5 Capacity: 4000 kVA

.6 Basic Impulse Level: 75 kV.

.7 Polarity: Additive.

.8 Windings: Copper

.9 Impedance: Not less than 5.75%

.10 Efficiency to conform to C802

2.4 Mounting

.1 Transformers suitable for pad mounting.

2.5 Vibration Dampers

.1 Anti-vibration mountings to isolate not less that 90% of disturbing vibrations.

2.6 Voltage Taps

.1 Four-2.5% taps, two-FCAN, two-FCBN.

2.7 Tap Changer

.1 Off-load type with external operating handle located for operation from ground level, with locking facilities and nameplate with markings to show tap voltages as actual voltages.

2.8 Cooling

.1 Equip with 208V, 3 phase, forced air cooling fans such that with operation of the air cooling fans, the kVA rating of transformer will be increased by 33-1/3%. Provide ampere capacity in primary bushings and secondary terminals for fan-cooled rating.

.2 Provide top oil temperature controller element.

.3 Provide control box containing starters and distribution wiring mounted on the transformer, factory-wired for a 120/208 volt power connection.

2.9 Sealed Tank

.1 Provide adequate capacity for the maximum increase in oil volume due to thermal expansion between extreme operating temperatures.

.2 Equip tank with magnetic oil level gauge easily readable from the ground.

2.10 Transformer Insulating Liquid

.1 To be fire retardant, non-corrosive, chemically degradable, thermally stable silicone or mineral oil, designed to operate with a metric 30 to 35°C rise insulation system.

2.11 Primary Bushings.

.1 Surround primary bushings with a termination box to permit connection of incoming cables. Provide compression-type connectors.

.2 Provide adequate space for stress cone termination of incoming power cables.

2.12 Secondary Bushings

.1 Surround secondary terminals with a terminal box for a flanged throat connection to match connection on main secondary cables/cable duct.

.2 Ground the secondary neutral in the 4160/600 V switchgear.

2.13 Throat Connections

.1 Extend secondary terminals through a throat connection to cable and/or duct.

2.14 Control Junction Box

.1 Provide control wiring junction box with terminal strip. Wire temperature and sudden pressure alarms and fan controls to terminal strip using rigid conduit and wire. Provide four spare terminals on terminal strip. Make the control junction box use easily accessible from the floor level.

.2 Terminals and wire markers are as specified in Section 16151 – Wire and Box Connectors 0-1000V.

2.15 Exterior Finish

.1 Bonderize and thoroughly clean all exterior surfaces. Apply a zinc chromate primer and two coats of finish enamel, special colour is to be as specified in Section 16010 – Electrical General Requirements.

.2 Provide 4 cans of spray paint for touch-up after installation.

DISTRIBUTION TRANSFORMERS - LIQUID COOLED

2.16 Identification

.1 Provide lamacoid nameplates with 12 mm letters per Section 16010 – Electrical General Requirements.

.2 City's Equipment Reference Label:

2.17 Accessories

.1 Equip transformer with all standard accessories as required by CSA Standard CAN3-C88. Items required are:

.2 Hanger irons and adapter plates.

.3 Top filter press connection.

.4 Liquid Celsius temperature measuring device, maximum indicating type, dial size 100mm with two sets contacts.

.5 Liquid level gauge without contacts.

.6 Gas detector relay with one set contacts.

.7 Wiring and terminal box for protective devices.

.8 Top non-flammable insulating liquid sampling device.

.9 Anchor devices, setting templates means for bolting down.

.10 Bi-directional skid base.

.11 Vacuum Pressure Gauge: Dial size 100mm.

.12 Factory install accessories.

.13 25 mm drain valve with plug and sampling valve.

.14 Sudden pressure change relay with alarm contacts.

.15 Primary bushings in termination box for cable connection.

.16 Secondary bushings in terminations box for cable bus connection.

.17 Control junction box.

.18 EEMAC2 Enclosure c/w drip hood and lifting eyes.

.19 Pressure relief vent.

.20 115 mm switchboard-type thermostat, 250°scale, with alarm contacts (hi and hi-hi).

.21 Stainless steel nameplate and connection diagram.

.22 Provision for lifting, jacking, and skidding.

.23 Ground studs and lugs.

3. EXECUTION

3.1 Installation

.1 Install transformers only after other work in area is completed.

.2 Install transformers as indicated on the Drawings and in accordance with the manufacturer's recommendations.

.3 Use spreader bars on slings when lifting transformers into place.

.4 Set and secure transformers in place rigid, plumb, square.

.5 Ensure internal connections are mechanically tight.

.6 Make power and control and monitoring connections.

.7 Connect transformer ground terminal to system ground.

.8 Fill transformers when required with metal hose and ensure care is taken to prevent contamination of liquid and components.

.9 Set taps to produce rated secondary voltage at no-load.

.10 Wire one set contacts on liquid temperature measuring device, gas detector relay, to Powerlogic monitoring contacts in main primary breaker in switchboard to indicate when unsafe condition reached,

.11 Mount the transformers on housekeeping pads; ensure that the pads are true and level. Mount the transformer assembly on the isolators as recommended by the manufacturer. Ensure concrete pad is fully cured for 28 days before installation of transformer.

.12 Connect the high temperature contact to alarm circuit as indicated and to trip the main secondary vacuum circuit breaker.

.13 Before energization, keep transformers or storage room enclosure above 10°C, ambient.

3.2 Testing (Coordinate with Section 16980)

.1 After the transformers have been set in place, prior to energizing, verify in writing that the transformers have been installed and tested in accordance with recommended practice and are suitable for energizing and use.

.2 Without limiting the foregoing, include the following, as a minimum:

.1 Prior to connecting, inspect visually and conduct the following tests:

.1 Megger insulation and correct reading to 20°C base. Megger high voltage to ground with the secondary grounded for the duration of the test. Megger low voltage to ground with the primary grounded for the duration of the test.

.2 Perform electrical centres test on high voltage off-load tap changer switch.

.3 Sample transformer insulating liquid laboratory analysis to be carried out as follows:

.1 Dielectric breakdown

.2 Neutralization number

.3 Colour

.4 Interfacial tension

.5 Specific gravity

.4 Leak test piping.

.5 Perform ratio test for all transformer gap positions.

.1 Verify that shipping braces and shipping shims have been removed.

.2 After connection of line, load, control, and alarm wiring, but prior to energizing, the calibration and verification firm is to inspect the installation and confirm the following:

.1 That the transformer has been properly cleaned, is dry and free of foreign materials and contaminants, and otherwise is suited for energizing.

.2 That all bus and connector bolts have been installed, tightened, torqued properly, and uninsulated surfaces of connectors and buses have been taped.

.3 That transformer taps have been set to provide secondary voltage required.

.4 That all insulators are in perfect condition, without cracks, chips, or surface contaminants.

.5 That core, coil, terminal boards, tap changers, bushings and all insulated surfaces have not been damaged.

.6 That the forced cooling fans are functioning and that the power supply circuits to the fans have been properly connected and protected.

.7 That all alarm and indicating devices are operating correctly, and are properly connected either internally or externally from the terminal of the instrument to the external system, including the following:

.1 Liquid level and pressure

.2 Liquid temperature, with hi and hi-hi contacts connected to the building control computer

.3 Sudden pressure is unblocked and wired to trip the primary circuit breaker.

.3 Any other tests or inspections deemed necessary or appropriate by the manufacturer.

3.3 Training

.1 Provide demonstration and training on equipment operation and maintenance in accordance with Section 01664 Training and Section 16990 Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

PAD MOUNTED DISTRIBUTION TRANSFORMERS

1. DESCRIPTION

1.1 Description

.1 Provide transformers to transform primary 4160 volt, 3 phase, 3 wire supply to main secondary distribution voltage of 600 volt, 3 phase, 4 wire.

.2 Use transformers that are suitable for operation in parallel.

1.2 Codes and Standards

.1 The transformers are to be built to CSA Specifications CAN/CSA-C2.

.2 EEMAC L9-3, interchangeability of HV bushings on pole-type distribution transformers.

1.3 Source Quality Control

.1 Submit production test certificates to Contract Administrator.

1.4 Tests

.1 Conduct tests in accordance with Sections 16010 – Electrical General Requirements and 16980 – Testing, Adjusting, and Balancing of Electrical Equipment and System.

.2 Completely factory test each transformer and the results certified, proving the performance of the units to provide capacities as listed in these Specifications.

.3 Factory tests for each transformer to include:

.1 Resistance measurements of all windings

.2 Ratio test at rated connection and on all taps

.3 Polarity and phase relation tests

.4 Audible sound level tests

.5 No-load loss at rated voltage and losses at 25%, 50%, 75%, and 100% load

.6 Exciting current at rated voltage

.7 Laboratory test of insulating liquid

.8 Impedance

.9 Applied potential test

PAD MOUNTED DISTRIBUTION TRANSFORMERS

.10 Induced potential test

.11 95 kV B.I.L. test

.12 Hi-pot test

.13 Heat run, temperature rise tests on each transformer

The above heat run tests and impulse tests to be witnessed by the Contract Administrator.

.4 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20°C:

.1 High voltage to ground with secondary grounded for duration of test

.2 Low voltage to ground with primary grounded for duration of test

.3 High to low voltage.

.5 Inspect primary and secondary connections for tightness and for signs of overheating.

.6 Inspect and clean bushings and insulators.

.7 Check oil level and temperature indicators.

.8 Set transformer taps to rated voltage as specified.

.9 Inspect for oil leaks and excessive rusting.

.10 Inspect for oil level.

.11 Check fuses for correctness of type and size.

.12 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

.13 Notify the Contract Administrator three weeks in advance, in writing, of the time, date, and place of the tests. This test will be attended first by the Contract Administrator and the City at the City's expense. Any subsequent witness tests, due to any reason whatsoever, shall be at the expense of the equipment manufacturer, but at the direction of the Contract Administrator.

.14 Witness tests may be waived by the Contract Administrator at his discretion; such waiver shall be in writing and shall not imply any acceptance by the Contract Administrator limit the liability of the manufacturer. A copy of the test results is to accompany the transformer when shipped.

PAD MOUNTED DISTRIBUTION TRANSFORMERS

1.5 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 - Submittals

.2 Indicate:

.1 Dimensioned positions of mounting devices.

.2 Dimensioned positions of terminations.

.3 Internal and external component layout on assembly drawing.

.4 Insulating liquid capacity.

.3 At completion of work and prior to final acceptance, provide maintenance manuals for all items specified in this section, in accordance with Section 01730 – Operations and Maintenance Manuals, including all test results.

1.6 Maintenance Data

.1 Provide maintenance data for liquid cooled transformers for incorporation into manual specified in Section 01730 – Operations and Maintenance Manuals and Section 16010 – Electrical General Requirements.

.2 Include insulating liquid maintenance data.

1.7 Maintenance Materials

.1 Provide any specialty tools or maintenance materials required for proper maintenance of transformers..

1.8 Delivery and Storage

.1 Ship transformers complete with first fill of liquid.

2. PRODUCTS

2.1 Manufacturer

.1 Primary and secondary terminals on opposite sides.

2.2 25kV Transformer Characteristics

.1 **Not Used**

2.3 5kV Transformer Characteristics

.1 Transformers: To CSA C2.

PAD MOUNTED DISTRIBUTION TRANSFORMERS

.2 Liquid cooled, outdoor, distribution transformers type ONAN with provision for fan cooling.

.3 Primary Voltage: 4160 V, 60 Hz, delta connected, 3 phase, 3 wire suitable for delta-wye connection,

.4 Secondary Voltage: 600 V, wye connected, 3 phase, 4 wire, grounded neutral suitable for delta-wye connection.

.5 Capacity: 3000 kVA

.6 Basic Impulse Level: 75 kV.

.7 Polarity: Additive.

.8 Windings: Copper

.9 Impedance: Not less than 5.75%

.10 Efficiency to conform to C802

2.4 Mounting

.1 Transformers suitable for pad mounting.

2.5 Vibration Dampers

.1 Anti-vibration mountings to isolate not less that 90% of disturbing vibrations.

2.6 Voltage Taps

.1 Four-2.5% taps, two-FCAN, two-FCBN.

2.7 Tap Changer

.1 Off-load type with external operating handle located for operation from ground level, with locking facilities and nameplate with markings to show tap voltages as actual voltages.

2.8 Cooling

.1 Equip with 208V, 3 phase, forced air cooling fans such that with operation of the air cooling fans, the kVA rating of transformer will be increased by 33-1/3%. Provide ampere capacity in primary bushings and secondary terminals for fan-cooled rating.

.2 Provide top oil temperature controller element.

.3 Provide control box containing starters and distribution wiring mounted on the transformer, factory-wired for a 120/208 volt power connection.

2.9 Sealed Tank

.1 Provide adequate capacity for the maximum increase in oil volume due to thermal expansion between extreme operating temperatures.

.2 Equip tank with magnetic oil level gauge easily readable from the ground.

2.10 Transformer Insulating Liquid

.1 To be fire retardant, non-corrosive, chemically degradable, thermally stable silicone or mineral oil, designed to operate with a metric 30 to 35°C rise insulation system.

2.11 Primary Bushings.

.1 Surround primary bushings with a termination box to permit connection of incoming cables. Provide compression-type connectors.

.2 Provide adequate space for stress cone termination of incoming power cables.

2.12 Secondary Bushings

.1 Surround secondary terminals with a terminal box for a flanged throat connection to match connection on main secondary cables/cable duct or busduct.

.2 Ground the secondary neutral in the 600 V switchgear.

2.13 Throat Connections

.1 Extend secondary terminals through a throat connection to cable and/or busduct.

2.14 Control Junction Box

.1 Provide control wiring junction box with terminal strip. Wire temperature and sudden pressure alarms and fan controls to terminal strip using rigid conduit and wire. Provide four spare terminals on terminal strip. Make the control junction box use easily accessible from the floor level.

.2 Terminals and wire markers are as specified in Section 16151 – Wire and Box Connectors 0-1000V.

2.15 Exterior Finish

.1 Bonderize and thoroughly clean all exterior surfaces. Apply a zinc chromate primer and two coats of finish enamel, special colour is to be as specified in Section 16010 – Electrical General Requirements.

.2 Provide 4 cans of spray paint for touch-up after installation.

2.16 Identification

.1 Provide lamacoid nameplates with 12 mm letters per 16010 – Electrical General Requirements.

.2 City's Equipment Reference Label.

2.17 Accessories

.1 Equip transformer with all standard accessories as required by CSA Standard CAN3-C88. Items required are:

.1 Hanger irons and adapter plates.

.2 Top filter press connection.

.3 Liquid Celsius temperature measuring device, maximum indicating type, dial size 100mm with two sets contacts.

.4 Liquid level gauge without contacts.

.5 Gas detector relay with one set contacts.

.6 Wiring and terminal box for protective devices.

.7 Top non-flammable insulating liquid sampling device.

.8 Anchor devices, setting templates means for bolting down.

.9 Bi-directional skid base.

.10 Vacuum Pressure Gauge: Dial size 100mm.

.11 Factory install accessories.

.12 25 mm drain valve with plug and sampling valve.

.13 Sudden pressure change relay with alarm contacts.

.14 Primary bushings in termination box for cable connection.

.15 Secondary bushings in terminations box for cable bus connection.

.16 Control junction box.

.17 EEMAC2 Enclosure c/w drip hood and lifting eyes.

.18 Pressure relief vent.

.19 115 mm switchboard-type thermostat, 250°scale, with alarm contacts (hi and hi-hi).

.20 Stainless steel nameplate and connection diagram.

.21 Provision for lifting, jacking, and skidding.

.22 Ground studs and lugs.

.2 Equip transformer with a T60 transformer protection relay as per Single Line Diagrams. Connect the "shut-Down" alarm contact back to the 5kV Switchgear unit controlling the power feed to the transformer.

.3 Equip transformer with a 600Amp Load Break Switch and Primary Lightning Arrestor as per Single Line Diagrams.

3. EXECUTION

3.1 Installation

.1 Install transformers only after other work in area is completed.

.2 Install transformers as indicated on the Drawings and in accordance with the manufacturer's recommendations.

.3 Use spreader bars on slings when lifting transformers into place.

.4 Set and secure transformers in place rigid, plumb, square.

.5 Ensure internal connections are mechanically tight.

.6 Make power and control and monitoring connections.

.7 Connect transformer ground terminal to system ground.

.8 Fill transformers when required with metal hose and ensure care is taken to prevent contamination of liquid and components.

.9 Set taps to produce rated secondary voltage at no-load.

.10 Wire one set contacts on liquid temperature measuring device, gas detector relay, to the monitoring contacts in main primary breaker in switchboard to indicate when unsafe condition reached,

.11 Mount the transformers on housekeeping pads; ensure that the pads are true and level. Mount the transformer assembly on the isolators as recommended by the manufacturer. Ensure concrete pad is fully cured for 28 days before installation of transformer.

.12 Connect the high temperature contact to alarm circuit as indicated and to trip the main secondary vacuum circuit breaker.

.13 Before energization, keep transformers or storage room enclosure above 10°C, ambient.

3.2 Testing (Coordinate with Section 16980)

.1 After the transformers have been set in place, prior to energizing, verify in writing that the transformers have been installed and tested in accordance with recommended practice and are suitable for energizing and use.

.2 Without limiting the foregoing, include the following, as a minimum:

.1 Prior to connecting, inspect visually and conduct the following tests:

.1 Megger insulation and correct reading to 20°C base. Megger high voltage to ground with the secondary grounded for the duration of the test. Megger low voltage to ground with the primary grounded for the duration of the test.

.2 Perform electrical centres test on high voltage off-load tap changer switch.

.3 Sample transformer insulating liquid laboratory analysis to be carried out as follows:

.1 Dielectric breakdown

.2 Neutralization number

.3 Colour

.4 Interfacial tension

.5 Specific gravity

.4 Leak test piping.

.5 Perform ratio test for all transformer gap positions.

.1 Verify that shipping braces and shipping shims have been removed.

.2 After connection of line, load, control, and alarm wiring, but prior to energizing, the calibration and verification firm is to inspect the installation and confirm the following:

.1 That the transformer has been properly cleaned, is dry and free of foreign materials and contaminants, and otherwise is suited for energizing.

.2 That all bus and connector bolts have been installed, tightened, torqued properly, and uninsulated surfaces of connectors and buses have been taped.

.3 That transformer taps have been set to provide secondary voltage required.

.4 That all insulators are in perfect condition, without cracks, chips, or surface contaminants.

.5 That core, coil, terminal boards, tap changers, bushings and all insulated surfaces have not been damaged.

.6 That the forced cooling fans are functioning and that the power supply circuits to the fans have been properly connected and protected.

.7 That all alarm and indicating devices are operating correctly, and are properly connected either internally or externally from the terminal of the instrument to the external system, including the following:

.1 Liquid level and pressure

.2 Liquid temperature, with hi and hi-hi contacts connected to the building control computer

.3 Sudden pressure is unblocked and wired to trip the primary circuit breaker.

.3 Any other tests or inspections deemed necessary or appropriate by the manufacturer.

3.3 Training

.1 Provide demonstration and training on equipment operation and maintenance in accordance with Section 01664 Training and Section 16990 Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

PRIMARY LIGHTNING ARRESTERS

1. GENERAL

1.1 References

.1 Gapless Metal Oxide Surge Arresters for Alternating Current Systems. - CAN/CSA - C233.1.

.2 ANSI/IEEE C62.36, Surge Protectors Used in Low Voltage Data Communications and Signaling Circuits, Standard Test Methods. - ANSI/IEEE C62.36.

1.2 Product Data

.1 Submit product data in accordance with Section 01300 – Submittals.

2. PRODUCTS

2.1 Materials

.1 Arrester component parts to CAN/CSA C233.1 and ANSI/IEEE C62.36.

.2 Arrester characteristics.

.1 Distribution arrester.

.2 System highest voltage line to ground: 4.16 kV.

.3 MCOV (maximum continuous operating voltage): 4.16kV.

.4 Indoor type.

.5 Housing: Polymer.

3. EXECUTION

3.1 General

.1 Cadweld or approved compression cable connections are acceptable.

.2 Make all conductor runs as short and straight as possible and perpendicular or parallel to building lines/planes.

3.2 Arresters

.1 Mount arresters in primary Switchgear adjacent to service cable connection point ahead of main breaker

.2 Connect line terminals to phase conductors.

.3 Mount arresters adjacent to primary cable of primary switchgear and connect line terminals to phase conductors. Connect ground terminals to ground bus.

END OF SECTION

INTERLOCK SYSTEMS

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

2. PRODUCTS

2.1 Interlock Systems

.1 Key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door to prevent:

.1 Opening cubicle door for access to fuses while load interrupter is in closed position.

.2 Closing load interrupter while cubicle door is open.

.2 Key interlocks Type F for main circuit breaker and Type F for Enmax group operated cross arm mounted isolating switch to prevent:

.1 Opening isolating switch while main circuit breaker is closed.

.2 Closing circuit breaker while isolating switch is open.

.3 Key interlocks, Type T, key transfer with Type F for main isolating switch and circuit breakers to prevent:

.1 Opening isolated switch until all circuit breakers are open.

.2 Closing any or all circuit breakers while isolating switch is open.

.4 Electric interlocks for main power breaker and tie power breaker to prevent:

.1 Tie power breaker closing unless one preferred power breaker is open.

.2 Main power breaker closing unless tie breaker is open.

.5 Electrical interlock between preferred power circuit breaker and standby power circuit breaker to prevent:

.1 Standby power breaker closing unless preferred power breaker is open.

.2 Preferred power breaker closing unless standby power breaker is open.

.6 Key interlocks mounted in switchgear so that interlocks can not be removed when operating breaker is in closed position.

2.2 Manufacturer

.1 Kirk Interlocks and Schneider Canada Service.

3. EXECUTION

3.1 N/A

END OF SECTION

SECONDARY SWITCHGEAR

1. GENERAL

1.1 References

.1 EEMAC G8-3.3, Metal-Enclosed Interrupter Switchgear Assemblies.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 01300 – Submittals .

.2 Indicate on shop drawings:

.1 Floor anchoring method and foundation template.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned position and size of bus.

.4 Overall length, height and depth of complete switchgear.

.5 Dimensioned layout of internal and front panel mounted components.

.3 Indicate on product data:

.1 Time-current characteristic curves for air circuit breakers.

1.3 Maintenance Data

.1 Provide maintenance data for secondary switchgear for incorporation into manual.

1.4 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 – Provide any specialty tools and materials required for proper maintenance of the switchgear.

.2 Include:

.1 3 fuses for each type above 600 A.

.2 6 fuses for each type up to and including 600 A.

.3 Software to program circuit breaker relays

1.5 Source Quality Control

.1 Notify Contract Administrator in writing 7 days in advance that switchgear assembly is ready for testing.

.2 Submit 3 copies of certified test results.

1.6 Storage

.1 Store switchgear on site in protected, dry location. Cover with plastic to keep off dust and contaminants.

.2 Provide energized strip heater in each cell to maintain dry condition during storage.

2. PRODUCTS

2.1 Materials

.1 Switchgear assembly: to EEMAC G8-3.3.

2.2 Rating

.1 Secondary switchgear: indoor 600 V, 4000 A, 3 phase, 3 wire, 60 Hz, minimum short circuit capacity 65 kA (rms symmetrical).

2.3 Enclosure

.1 Main incoming section to contain:

.1 Air circuit breaker sized as indicated.

.2 Electronic Circuit monitor, ION 7550 c/w Ethernet communication and I/O cards and panel meter

.3 Provision for, current transformers and potential transformers.

.2 Distribution sections to contain:

.1 Air circuit breaker sized as indicated.

.2 Copper bus, from main section to distribution sections including vertical bussing.

.3 Ground fault protection devices.

.3 Blanked off spaces for future units. Spaces to be ready and complete to accept new breakers without switchboard shutdown.

.4 Metal enclosed, free standing, floor mounted, dead front, indoor, CSA Enclosure multi cubicle unit.

.5 Ventilating louvres: vermin, insect proof with easily replaceable fiber glass filters.

.6 Access from front and rear.

.7 Steel channel sills for base mounting in single length common to multi-cubicle switchboard.

.8 Provision for future extension on both sides

2.4 Busbars

.1 Three phase and full capacity neutral baebusbars, continuous current rating 4000A, self-cooled, extending full width of multi-cubicle switch board, suitably supported on insulators.

.2 Main connections between bus and major switching components to have continuous current rating to match major switching components.

.3 Busbars and main connections: 99.30% conductivity copper.

.4 Provision for extension of bus on both sides of unit without need for further drilling or preparation in field.

.5 Tin plated joints, secured with non-corrosive bolts and Belleville washers.

.6 Identify phases of busbars by suitable marking.

.7 Busbar connectors, when switchboard shipped in more than one section.

2.5 Grounding

.1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.

.2 Lugs at each end for size 3/0 AWG grounding cable.

2.6 Air Circuit Breaker

.1 Refer to Section.16476

2.7 Feeder Protection

.1 Provide Solid State Feeder and Motor Protection relays for each load as indicated on drawings.

2.8 Instrument Transformers

.1 Refer to Section 16432

2.9 Metering and Instruments

.1 Refer to Section 16431

.2 Separate compartment and metal raceway for current transformers and potential transformers.

.3 Connect all meters to the central electrical monitoring system via the communications network.

.4 Mounting accessories and wiring for electronic metering

.1 3 potential transformers

.2 3 current transformers

.3 Watthour meter

.4 Demand meter with kWh register

.5 Ammeter

.6 Voltmeter

2.10 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.

.1 Cubicle exteriors gray.

.2 Cubicle interiors white

2.11 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Nameplates:

.1 Complete switchgear labeled: Equipment number and voltage

.2 Main cubicle labeled: "Main Breaker

.3 Distribution units labeled: "Breaker number and load being fed".

3. EXECUTION

3.1 Installation

.1 Locate switchgear assembly as indicated and bolt to base channels.

.2 Connect main secondary power supply to main breaker

.3 Connect load side of breakers in distribution cubicles to distribution feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run two grounding conductor 4/0 AWG bare copper in 25 mm conduit from each end of ground bus to ground.

3.2 Training

.1 Provide demonstration and training on equipment operation and maintenance in accordance with Section 01664 – Training and Section 16990 – Electrical Equipment and System Demonstration and Instruction

3.3 Testing and Calibration

.1 Program and check trip unit settings against co-ordination study to ensure proper working and protection of components.

.2 Provide Switchgear and System testing as per Section 16030 Electrical Testing.

END OF SECTION

DISTRIBUTION PANELBOARDS

1. GENERAL

1.1 Description

.1 Provide panelboards for 600 and 120/208 V branch circuit distribution as indicated on schedules shown on the Drawings, complete with all items listed.

.2 Construct panelboards to CSA Standards, apply CSA approval labels.

.3 Panelboards to be manufactured by Eaton Cutler Hammer, Schneider or Siemens.

.4 To be read in conjunction with Section 16471 – Panelboards.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings on all panelboards, switchboards and CDPs in accordance with Section 01300 – Submittals.

.2 Drawings to include electrical details of panel, branch breaker types and ratings, bussing type and rating and enclosure type and dimensions

2. PRODUCTS

2.1 Materials

.1 Tub: CSA code gauge galvanized steel, reversible top and bottom, finish painted ANSI 61 grey enamel or as specified in Section 16010 – Electrical General Requirements.

.2 Mains: Copper, ampere ratings as shown, solderless lug connectors sized for cables in panels without main breakers, bolt-on connectors for all main breakers and branch circuit breakers.

.3 Neutral Bars: Same ampere ratings as mains, solderless lugs for connections.

.4 Front shields to cover breaker assembly and neutral bars, leaving wiring gutters accessible when fronts removed.

.5 Front Covers, Doors: CSA code gauge galvanized steel, with doors, concealed hinges, combination locks and latches, interior plastic covered circuit directory cardholders, concealed mounting screws, finish painted, same size as tubs where surface mounted, overlapping trim with wall gaskets where flush mounted.

.6 Locks, Keys: All locks to be keyed alike.

.7 Branch Circuit Breakers: Thermal magnetic with "ON", "OFF" and "TRIPPED" positions, single, two and three pole as shown; ampere ratings as shown; bolt-on line connections, solderless lug load connections; common trip for two and three pole; rated 240 V 10,000 A symmetrical short circuit interrupting capacity in 120/208 V panelboards; rated 600 V,

22,000 A, symmetrical short circuit interrupting capacity in 600 V panelboards, unless otherwise indicated.

.8 Spaces: Stamp out spaces, install removable fillers where breaker spaces are shown.

.9 Ground Fault Circuit Interrupters: Install breakers having both 5 ma ground fault sensitivity and over current protection, of the amperage rating indicated, in the panelboards, where required. Wire each ground fault breaker with a separate neutral conductor wired through the interrupter to the ground bus.

.10 Provide a minimum of 3 locking straps for each 600V Panelboard.

3. EXECUTION

3.1 Mounting

.1 Mount panel boards inside of main power distribution cabinet.

3.2 Wiring

.1 Install branch circuit wiring in neat bundles at sides of wiring gutters, with wires to branch breakers horizontal.

3.3 Identification

.1 Provide lamacoid plate securely and permanently attached to the exterior of each panelboard door showing panelboard designation, voltage, and source of feed.

.2 For all ground fault breakers, provide a sign indicating that circuits are so protected and that equipment should be tested regularly.

3.4 Branch Circuit Directory

.1 Provide typed directory identifying all branch circuits. Directory to indicate device and location.

3.5 Locking Straps

.1 Locking Straps: To permit automatic tripping of breakers but prevent manual switching, for exit lights, receptacles feeding emergency battery packs, fire alarm panels and where designated.

3.6 Keys

.1 Provide three (3) keys.

END OF SECTION

METERING AND SWITCHBOARD INSTRUMENTS

1. GENERAL

1.1 Description

.1 Digital Power Instrumentation Package - Full-Featured

.1 Provide Digital AC Instrumentation Package including switchboard instruments and communication wiring to local Ethernet backbone.

.2 The Digital Power Instrumentation Package to be an ION 7550 Digital Power Meter.

1.2 Reference Standards

.1 Conform to the following standards:

.1 ANSI/IEEE C37.90A surge withstand and fast transient tests.

.2 FCC Part 15 Subpart J for Class A computing devices.

.3 NEMA 250 standards factory finishes.

1.3 Submittals for Review

.1 Submit Shop Drawings in accordance with Section 01300 – Submittals and Section 16010 – Electrical General Requirements.

.2 Indicate meter, instrument outline dimensions, panel drilling dimensions and include cutout template.

.3 Provide wiring details for monitoring equipment.

1.4 Submittals

.1 Submit product data in accordance with Section 01300 and Section 16010.

.2 Provide instrument installation and operation manual(s) and troubleshooting guide(s). Provide serial communications protocol document(s).

2. PRODUCTS

2.1 Digital Power Instrumentation Package - Full-Featured

.1 Provide and install the Digital AC Instrumentation Package capable of measuring, calculating and directly displaying on the front panel display the following information:

.1 Volts on each phase plus average of all three phase.

.2 Current on each phase plus average of all three phases.

.3 Neutral or ground current.

.4 Frequency.

.5 Power factor.

.6 kVA.

.7 kVAR.

.8 kW.

.9 Total kWH as an accumulating total, providing bi-directional (import/export) indication.

.10 Total kVARH as an accumulating total, providing bi-directional (import/export) indication.

.11 kW Demand, user-programmable length of each demand period and the number of periods averaged to match local utility billing method.

.12 Amps Demand.

.13 kVA Demand, user-programmable length of each demand period and the number of periods averaged to match local utility billing method.

.2 The instrumentation package to have:

.1 True RMS measurement.

.2 Direct connection to 600 Volt, 3 phase, 4 wire system.

.3 Fourth current input for measurement of ground or neutral current.

.4 Four status inputs rated 9 VAC/VDC = inactive, >20 VAC/VDC = active, maximum 277 VAC/VDC, to remotely monitor breaker status, ground fault relay status, or any other dry contact input. One of the inputs can be used to synchronize the measurement of kW Demand or kVA Demand to a utility kW Demand or kVA Demand start pulse. One input can be used as a pulse counter.

.5 One auxiliary analog input rated 1.0 VAC/VDC nominal full scale input which can be used to measure an external variable such as transformer temperature, air temperature, or battery voltage.

.6 One auxiliary analog output (selectable 0-20 mA or 4-20 mA) proportional to any measured parameter.

.7 Three Form C dry contact control relay outputs rated 277 VAC or 30 VDC at 10 Amp maximum load current that can each function as:

.1 Setpoint relays that operate as a function of any measured parameter for demand, power factor, or load control. Seventeen programmable setpoints shall each have programmable operate and release limits, and time delays on operate and release. Provide relays with selectable pulse mode or latch mode operation.

.2 Remote control relays operated by commands via the communications port.

.3 Breaker trip relay (over/under volt, volt unbalance, phase reversal, current unbalance, over/under frequency).

.4 kWH or kVARH pulse output relay.

.5 Alarm relays for monitoring breaker position status.

.8 Storage in non-volatile memory for the following:

.1 A time-stamped alarm and event log of up to 50 events which records event date, time (to 1 sec), event type, and value for all over/under limit conditions, all status input activity, and all relay operations. Log to be read via the communications port.

.2 A time-stamped minimum/maximum log, which records the value of any parameter exceeding the previous highest or lowest value recorded. Log to be read from the front panel display or via the communications port.

.3 A time-stamped snapshot (historical) log, with a 100 snapshot capacity and user-definable snapshot interval from 1 sec to 400 days which records snapshot values for Avg. Volts, Avg. Amps, kW, kVAR, kW Demand, Power Factor, frequency, kWH, kWH Reverse, kVARH, and Aux. Volts Input. Log to be read via the communications port.

.4 All setup data.

.9 Waveform capture capability allowing any of the eight voltage and current input channels to be digitally sampled at 128 samples/60 Hz cycle. Waveform capture to be initiated using commands made via the communications port. Waveform capture data is to be made accessible via the communications port.

.10 3-field, 20 character, high visibility 10 mm character height vacuum-fluorescent display with a programmable time out feature.

.11 Serial communications port which has:

.1 Switchable 1RS-232C and RS-485 capability.

.2 Addressable polling of multiple units.

.3 Packet transmission.

.4 Selectable transmission at 300 to 19,200 baud.

.12 Field programmability as follows:

.1 Volts scale, volts mode (wye, delta, single phase), amps scale, Vaux scale, baud rate and the relay operation are programmable from the front panel.

.2 All parameters in 12.1 above, plus additional alarm/event parameters may be programmed via the communications port using a portable terminal or a computer.

.3 Ensure programming is password protected.

.13 Compliance with the following standards:

.1 UL certified.

.2 CSA approved.

.3 Voltage, current, status, relay and power inputs pass the ANSI/IEEE C37.90A surge withstand and fast transient tests.

.4 Certified to comply with FCC Part 15 Subpart J for Class A computing devices.

.14 300 amps for one second surge protection on all four current inputs.

.15 The following accuracy, resolution, range, and power supply ratings specifications:

Parameter	Accuracy	Resolution	Range
Volts (V1, V2, V3)	0.2%	0.1%	0 - 1,000,000[1]
Amps (I1, I2, I3)	0.2%	0.1%	0 - 30,000
Neutral Current (I4)	0.2%	0.1%	0 - 9,999
kW	0.4%	0.1%	0 - 1,000,000[2]
kVAR	0.4%	0.1%	0 - 1,000,000[2]
kVA	0.4%	0.1%	0 - 1,000,000[2]
Power Factor	1.0%	1.0%	1.0 to ±0.6
Frequency	0.2 Hz	0.1 Hz[3]	40 to 450 Hz
kW Demand	0.4%	0.1%	0 - 1,000,000
Amps Demand	0.2%	0.1%	0 - 30,000
kWH (-F, -R)	0.4%	1 kWH	0 - 1,000,000,000
kVARH (-F, -R)	0.4%	1 kVARH	0 - 1,000,000,000
V_{aux} Input (1 VAC scale)	0.25%	0.1%	0 - 1,000,000
I_{out} Output(0-20 mA)	2%	n/a	n/a
Waveform Capture	0.5%of full scale	10 bits(0.1%)	n/a

.1 Reads in kV for voltages over 9,999.

.2 Reads in MVA, MW, MVAR for readings over 9,999 K.

.3 1 Hz resolution at 400 Hz range.

.4 For -XTEMP option derate accuracy by 0.01%/°C below 0°C and above 50°C.

.3 Power Supply

.1 5-132 VAC/0.2 Amps/47-440 Hz or 110-170 VDC/0.2 Amps.

.4 Communication

.1 Provide a multi-port communication card that will support communications via three independent ports (1-RS232 and 1-RS485 and1 RJ45) concurrently.

.2 Communication card to be Power Measurement Model MPCC. Multilin or Powerlogic Ethernet equivalent.

.3 Provide an RS485 to RS232 converter unit where called for on the Process and Instrumentation Drawings that allows access via portable computer to the Power Measurement Communication bus. Converter to be Power Measurements Com 32 device.

.4 Meters are to be communications compatible with the Site central electrical monitoring system software. Provide software package if different from package installed under Contract 2S.

2.2 Potential Transformers

.1 Provide three (3) potential transformers.

.2 Provide Instrument PTs that are independent of protection PTs

2.3 Current Transformers

.1 Provide shorting switches or test blocks for all meter CT inputs.

.2 Provide Instrument CTs that are independent of protection CTs

2.4 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

3. EXECUTION

3.1 Field Testing and Inspection

.1 Conduct tests in accordance with Section 16030 and 16980 in accordance with manufacturer's recommendations.

.2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.

.3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources and electrical supplies.

3.2 Installation

.1 Mount in the control section of the appropriate switchgear breaker cubicle or adjacent meter compartment.

.2 Install appropriate potential transformer and current transformers required for sensing signals for the meter system.

.3 Install, wire and connect all electrical circuits to the instrumentation package and provide wiring to an external terminal strip for the relay outputs, digital status inputs and analog output port.

.4 Install, wire and connect the communications port of each meter and extend communications wiring to a location that is easily and safely accessible to facilitate diagnostics, testing and firmware upgrades.

3.3 Testing and Calibration

.1 Program and check trip unit settings against co-ordination study to ensure proper working and protection of components.

.2 Provide Switchgear and System testing as per Section 16030 Electrical Testing.

END OF SECTION

INSTRUMENT TRANSFORMERS

1. GENERAL

1.1 References

.1 CAN3-C13, Instrument Transformers.

1.2 Product Data

.1 Submit product data in accordance with Section 01300 – Submittals.

.2 Indicate dimensions and connection details.

2. PRODUCTS

2.1 Potential Transformers

.1 Potential Transformers: To CAN3-C13, dry type for indoor use, with following characteristics:

.1 Nominal Voltage Class: as indicated

.2 Rated Frequency: 60 Hz

.3 Basic Impulse Level: as indicated kV

.4 Voltage Ratio: as indicated

.5 Accuracy Rating: 0.3B2.0.

.2 Potential Transformers fused with separate fuse block Fuses: as indicated.

2.2 Current Transformers

.1 Current Transformers: To CAN3-C13,dry type for indoor use with following characteristics:.

.1 Nominal Voltage Class: as indicated

.2 Rated Frequency: 60 Hz

.3 Basic Impulse Level: as indicated kV

.4 Metering Accuracy Ratio: 0.3B2.0

.5 Relay Accuracy Rating: 2.5H100

.6 Rated Primary and Secondary Current: as indicated

.7 Continuous-Current Rating Factor: 150%

.8 Short-Time Mechanical Current Rating: 1.5 times primary rating

.9 Short-Time Thermal Current Rating: 1.5 times primary rating.

.2 Positive action automatic short-circuiting device in secondary terminals.

2.3 Mounting Brackets

.1 Potential transformers with channel type mounting brackets.

.2 Fabricate brackets and channels from electro-galvanized code gauge painted steel.

3. EXECUTION

3.1 Installation

.1 Install instrument transformers and ensure accessibility.

END OF SECTION

DISCONNECT SWITCHES - FUSED AND NON-FUSED UP TO 600 V - PRIMARY

1. GENERAL

1.1 Description

.1 Provide disconnect switches for 600 V and 120/208 V distribution as indicated on the Drawings, as manufactured by Eaton Cutler Hammer, Hubble or Schneider.

.2 Disconnect switches for equipment supplied under other Divisions will be supplied with the equipment. The Contractor shall install all disconnects supplied by under Divisions.

1.2 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300 – Submittals.

.2 Provide data for various sizes and types to be used

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 600 V for 600 V distribution, 240 V for 120/208 V distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the Drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. For disconnect switches in dry locations, use EEMAC-1 and EEMAC-4x in wet location or stainless steel EEMAC 4 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: One (1) primer coat and one (1) finish coat on all metal surfaces, colours as per Section 16010 – Electrical General Requirements.

.4 Switch mechanisms: Quick make and quick break action with self wiping contacts, solderless pressure lug connectors. For switches 100 A and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in "OFF" position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in “ON” position.

.5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

.1 All fuses to be 100,000 A (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type.

2.3 Spare Parts

.1 Provide one (1) full set of spare fuses, three for each different ampere rating used, stored in suitable enclosure.

3. EXECUTION

3.1 Disconnect Switches

.1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped, mount in uniform arrangement.

.2 Wiring: Connect line and load cable to all switches.

.3 Fuse Rating: Install so that rating is visible.

.4 Identification: Provide lamacoid plate in accordance with Section 16010 – Electrical General Requirements, on each switch showing voltage, source of supply and load being fed.

.5 Example:

.1 Mixer MX-05A-161

.2 600 V

.3 Fed from MC-06A-901

END OF SECTION

GROUNDING - SECONDARY

1. GENERAL

1.1 Description

.1 Supply and install a complete secondary grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code and the local Electrical Inspection Branch.

.2 The system is to consist of cables, ground rods, supports, and all necessary materials and inter-connections to provide a complete system. Ensure measured resistance to ground of the network does not exceed 5 ohms.

.3 Run all ground conductors in conduit.

.4 Co-ordinate with Primary grounding in Section 16160

1.2 References

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

2. PRODUCTS

2.1 Equipment

.1 Connect cables 3/0 and smaller to ground bars via Burndy Quiklug Type QA-2B connectors. Braze connections for cables larger than 3/0.

.2 All ground wires: stranded copper TWH complete with a green jacket unless otherwise shown.

.3 Uninsulated ground wires: bare stranded copper, tinned, soft annealed. Size as indicated.

.4 Copper conductor: minimum 6 m long for each concrete encased electrode, bare, stranded, tinned, soft annealed, size as indicated.

.5 Rod electrodes: copper clad steel 19 mm dia by 3 m long.

.6 Cable to pipe connectors: Burndy GAR connectors.

.7 In the main electrical room, provide a copper ground bar complete with lugs suitable to terminate all ground cables.

.8 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Thermit welded type conductor connectors.

.5 Bonding jumpers, straps.

.6 Pressure wire connectors.

3. EXECUTION

3.1 General

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, accessories. Where EMT or PVC conduits are used, run ground wire in conduit. Install all connectors in accordance with manufacturer's requirements. Ground all frames and metallic enclosures, of all electrical equipment, and electrically operated equipment via a ground wire.

.2 Ground all transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre by grounding conductors sized in accordance with the Canadian Electrical Code Terminate the ground wire at each end with an appropriate grounding lug connected to the equipment ground bus. Ground wire to be green TWH. Use mechanical connectors for grounding connections to equipment provided with lugs.

.3 Ground all sub panels such as lighting panels, local distribution panels, etc., with a green ground wire run back to the panel from which it is fed or via the ground conductor supplied integral to a Teck Cable. Size the ground conductor according to the Canadian Electrical Code.

.4 Connect using bare copper conductors from the main electrical room ground bus to a minimum of 4 ground rods located adjacent to the transformers. Test the system for ground resistance before connecting the utility ground and install additional ground rods as necessary to meet the minimum requirements.

.5 Ensure all panels requiring equipment grounds contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.6 Make all bolted connections accessible.

.7 Ground all motors by means of an adequately sized green ground wire contained within the feeder conduit.

.8 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Canadian Electrical Code.

.9 Bond expansion joints and telescoping sections of raceways using jumper cables as per Canadian Electrical Code.

.10 Use Burndy compression connectors for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy "Durium" hardware.

.11 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.12 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.13 For conduit installed buried in earth or installed in or under grade floor slabs, install separate ground wire, whether the conduits are metal or not.

.14 Ground all utility services to the electrical system ground.

.15 Protect exposed grounding conductors from mechanical injury.

.16 Make buried connections, and connections to conductive electrodes, using copper welding by thermit process, permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.

.17 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.18 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.19 Do not use soldered joints.

.20 Install a separate ground conductor to all outdoor lighting standards.

.21 Connect building structural steel and metal siding to ground.

.22 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

.23 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

3.2 Manholes

.1 Install conveniently located grounding stud, electrode, and size as required stranded copper conductor in each manhole.

.2 Install ground rod in each manhole so that top projects through bottom of manhole. Provide with lug to which grounding connection can be made.

3.3 Electrodes

.1 Install rod electrodes and make grounding connections.

.2 Bond separate, multiple electrodes together.

.3 Use copper conductors sized as indicated for connections to electrodes.

.4 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

3.4 System and Circuit Grounding

.1 Install system and circuit grounding connections to neutral of primary 25 kV system, secondary zigzag grounding transformer of the 4.16 kV system and 600 V system.

3.5 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, distribution panels, and outdoor lighting.

3.6 Grounding Bus

.1 Install copper grounding bus mounted on insulated supports on wall of the main electrical room.

.2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded copper connections size 2/0 AWG.

3.7 Communication Systems

.1 Install grounding connections for telephone, data communications, fire alarm, intercommunication systems as follows:

.1 Telephones: make telephone grounding system in accordance with telephone company's requirements.

.2 Data communications, fire alarm, intercommunication systems as indicated.

3.8 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

3.9 Instrumentation and Control Cable Tray

.1 Where an instrumentation and control cable tray is installed, provide a #6 AWG ground conductor along the entire length of cable tray. Bond ground conductor to each section of tray. Home run ground conductor back to main building ground bus.

3.10 Training

.1 Provide demonstration and Training on equipment Operation and Maintenance in accordance with Section 01664 – Training and Section 16990 – Electrical Equipment and Systems Demonstration and Instruction

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

1. GENERAL

1.1 Description

.1 Provide enclosed dry type transformers 600 volts primary to 480 or 120/208 volts as indicated on the drawings.

1.2 Submittals

.1 Product Data - Three Phase, Four Wire Secondary

.1 Submit product data in accordance with Section 01300 – Submittals.

1.3 Quality Control

.1 Transformers to conform to CSA C57.12 and L2 standards, and are to be approved to CSA Code Part 2, Standard C22.2, No. 47 and CSA C9.

2. PRODUCTS

2.1 Transformers

.1 General: Dry type, air cooled, self ventilated. Enclosures to be CSA-1 or CSA -3R type, code gauge steel, complete with ventilating openings, access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16010. Transformers to be single or three phase as noted on the drawings. Dry type transformers: Square D, Hammond or Delta.

.2 Design

.1 Type: ANN

.2 3 phase, kVA as indicated, 600 V input, output voltage as indicated, 60 Hz.

.3 Voltage primary taps: 2.5% Full capacity above and below normal

.4 Insulation: Class H.

.5 Basic Impulse Level (BIL): 10 kV B.I.L.

.6 Hipot: 4 kV

.7 Average Sound Level: To meet the local municipal & building codes and meet at minimum the following criteria:

45 dB max. up to 45 kVA
50 dB max. up to 150 kVA

55 dB max. up to 300 kVA
60 dB max. above 500 kVA

.8 Impedance at 170°C: 6.0% max. up to 112½ kVA
5.5% max. above 112½ kVA

.9 Enclosure: As indicated suitable for area in which unit is to be installed.

.10 Mounting: Up to 45 kVA suitable for wall or floor mounting and above 45 kVA suitable for floor mounting unless otherwise shown.

.11 Finish: In accordance with Section 16010 - Electrical General Requirements.

.12 Three Phase Windings: Arrange with three primary copper windings connected in delta and three secondary copper windings connected in wye.

.13 Max. Winding Temperature: 150°C rise with temperature continuous full load

.14 Max. Lead Connection: 55°C rise with temperature continuous full load

2.2 Universal Harmonic Filters

.1 Not Used

2.3 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate equipment number, primary and secondary voltage, KVA rating, feeder source and equipment being fed

3. EXECUTION

3.1 Installation

.1 Mount dry type transformers up to 45 kVA as indicated.

.2 Mount dry type transformers above 45 kVA on floor.

.3 Ensure adequate clearance around transformer for ventilation

.4 Install transformers in level upright position.

.5 Remove shipping supports only after transformer is installed and just before putting into service.

.6 Loosen isolation pad bolts until no compression is visible.

.7 Make primary and secondary connections in accordance with wiring diagram.

.8 Mount transformers as indicated on drawings and connect primary, secondary, neutral and ground conductors. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

.9 Do not use permanent distribution system dry type transformers for temporary power distribution without permission for the Contract Administrator.

.10 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads.

.11 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 volts phase to neutral. Set tap connections for above 120 volts rather than below.

.12 Make connections to transformers in flexible conduit, entering the enclosure below the coils.

.13 Before energization, keep transformers or storage room enclosures above 10°C ambient.

3.2 SUPPLEMENTS

.1 The supplements listed below, following "End of Section", are part of this specification.

.1 Distribution Transformer Schedule.

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

SUPPLEMENT 1 – DISTRIBUTION TRANSFORMER SCHEDULE

Tag	DESCRIPTION	RATINGS	LOCATION	ENCLOSURE TYPE	POWER FROM
XFM-LP-A11	Transformer for LP-A11	45 kVA 600/120-20V 3 PHASE 4 WIRE	DAF Influent Gallery	CSA 3R	MCC1A
XFM-LP-A21	Transformer for LP-A21	75 kVA 600/120-20V 3 PHASE 4 WIRE	Administration Area 2nd Floor	CSA 1	MCC3B
XFM-LP-A31	Transformer for LP-A31	150 kVA 600/120-20V 3 PHASE 4 WIRE	Administration Area 3rd Floor	CSA 1	MCC4A
XFM-LP-C11	Transformer for LP-C11	45 kVA 600/120-20V 3 PHASE 4 WIRE	Maintenance Workshop Area	CSA 1	MCC2B
XFM-LP-F01	Transformer for LP-F01	30 kVA 600/120-20V 3 PHASE 4 WIRE	Filter Piping Gallery	CSA 3R	DP-F02
XFM-LP-H31	Transformer for LP-H31	75 kVA 600/120-20V 3 PHASE 4 WIRE	Electrical Room #2	CSA 1	MCC4A
XFM-LP-M11	Transformer for LP-M11	45 kVA 600/120-20V 3 PHASE 4 WIRE	Electrical Room #1	CSA 1	MCC2A
XFM-LP-P11	Transformer for LP-P11	30 kVA 600/120-20V 3 PHASE 4 WIRE	SBS Feed Room 1st Floor	CSA 1	MCC2B
XFM-LP-P31	Transformer for LP-P31	45 kVA 600/120-20V 3 PHASE 4 WIRE	DAF Pump Gallery	CSA 3R	DP-H32
XFM-LP-R21	Transformer for LP-R21	30 kVA 600/120-20V 3 PHASE 4 WIRE	Residuals Area 2nd Floor	CSA 3R	MCC3A
XFM-LP-R31	Transformer for LP-R31	30 kVA 600/120-20V 3 PHASE 4 WIRE	Mechanical Room #2	CSA 1	DP-R31
XFM-PSU-O310A	Transformer for PSU-O310A	250 kVA 600/480 V 3 PHASE 3 WIRE	Electrical Room #2	CSA 1	MCC4A
XFM-PSU-O320A	Transformer for PSU-O320A	250 kVA 600/480 V 3 PHASE 3 WIRE	Electrical Room #2	CSA 1	MCC4B
XFM-PSU-O330A	Transformer for PSU-O330A	250 kVA 600/480 V 3 PHASE 3 WIRE	Electrical Room #2	CSA 1	MCC4A

PANELBOARDS - BREAKER TYPE

1. GENERAL

1.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300 – Submittals.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity and ratings and enclosure type and dimensions.

2. PRODUCTS

2.1 Panelboards

.1 Panelboards: product of one (1) Manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 208 or 600 V panelboards: bus and breakers rated for symmetrical interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two (2) keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Trim with concealed front bolts and hinges.

.9 Trim and door finish: baked grey enamel.

.10 Provide CSA 3R enclosures for panels mounted in Process or Wet Locations. See Section 16010 Electrical Gen Requirements for area designations.

2.2 Breakers

.1 Breakers: to Section 16477 – Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

.1 Provide a minimum of 2 (two) "Lock-on" devices for each type of breaker in the panel.

2.3 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

3. EXECUTION

3.1 Installation

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height specified in Section 16010 – Electrical General Requirements or as indicated.

.4 Connect loads to circuits.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

AIR CIRCUIT BREAKERS

1. GENERAL

1.1 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Include time-current phase protection co-ordination characteristic curves for breakers.

2. PRODUCT

2.1 Air Circuit Breaker

.1 Air circuit breaker to: to ANSI/IEEE C37.13.

.2 Drawout type, 600 V class.

.1 Continuous current rating: As noted on drawings

.2 Trip rating as noted on drawings.

.3 Interrupting rating: as noted on drawings.

.3 Solid-state tripping system consisting of 1 current sensor per pole, 1 solid-state trip unit and self-powered trip actuator. Equip with long, short, instantaneous and ground fault function and phase overload ground fault indication. Unit to report breaker status, trip history, via a communications interface to the electrical monitoring system

.4 Breakers with normal stored energy, closing mechanism to provide quick-make operation for all ratings.

.5 Breakers with motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle (Mains and Tie only)

.6 Breakers with on-off indicator and spring charged/discharged indicator.

.7 Interlocks to prevent circuit breaker drawout when in closed position and to prevent closing unless fully engaged or in test position.

.8 Current limiting fuses in series and internally mounted up to 2000 A frame size. Provide in parallel to current limiting fuses, anti-single-phasing coils which act on tripper bar to prevent single phasing. Coordinate time current limiting characteristics of fuses with time current tripping characteristics of circuit breaker.

2.2 Optional Features

.1 LED display of breaker settings

.2 Shunt trip.

.3 120V AC charging motor

.4 Auxiliary switches 4 N.O., 4 N.C showing breaker status.

.5 Under voltage tripping device time delay.

.6 Alarm switch.

.7 Pilot light.

.8 Sync Check relay on mains/tie breaker.

.9 Control relay

.10 Electrical interlock. On Mains and Tie breaker

.11 Remote monitoring by central electrical monitoring system through Ethernet connections of power and harmonics.

.12 Lockout devices.

.13 Padlocking provision.

.14 Operation counter.

2.3 Acceptable manufacturers

.1 Square D, Power Zone 4 and Masterpac NW Breaker with Micrologic 5H electronic trip units

.2 Cutler Hammer , DSII Breaker and OPTIM 1050 electronic trip unit

.3 Siemens WL Breaker and ETU776 electronic trip unit,

2.4 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 and Section

.2 Provide nameplate indicating breaker number and load being fed

3. EXECUTION

3.1 Installation

.1 Install air circuit breakers as indicated.

.2 Connect electronic trip units to communicate with the Central electrical monitoring system

.3 Set all breakers trips according to the Co-ordination study results.

3.2 Sequence of Operation

.1 The two mains and tie breaker are to be operated in a closed transition mode during changeover from preferred to alternate supply. The sync check relay can verify phasing and will allow a manual closure of the open breaker if phasing is verified to be correct. The relay will also trip one of the three breakers, selected by means of a panel mounted selector switch, eight seconds after the open breaker is closed manually.

END OF SECTION

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

.1 Submit product data in accordance with Section 01300 – Submittals.

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000 A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

.2 Common-Trip Breakers: With single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from 3 to 8 times current rating.

.4 Provide circuit breakers with interchangeable trips as indicated.

.5 For breakers 400 A and larger, provide with solid state LSIG electronic trips.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection

2.4 Solid State Trip Breakers

.1 Moulded case circuit breaker to operate by means of a solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

2.5 Optional Features

.1 Include where indicated on Drawings:

.1 Shunt trip

.2 Auxiliary switch

.3 Motor-operated mechanism

.4 Under-voltage release

.5 On-Off locking device

.6 Handle mechanism

.7 Keyed interlocks

.8 Non-auto

.9 Solid state trip units.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated.

.2 Identification: In accordance with Section 16010 – Electrical General Requirements, provide lamicoid plate on each breaker showing voltage and load being fed. Example - Transformer TX-05A-902.

END OF SECTION

POWER SURGE PROTECTORS

1. GENERAL

1.1 Related Work

.1 Section 16010 – General Electrical Requirements.

.2 Section 16471 – Panelboards - Breaker Type.

1.2 System Description

.1 A transient voltage surge suppressor for the protection of downstream electronic equipment connected to the building power supply. Provide a unit compatible with non-linear loads, providing effective high-energy transient voltage suppression, surge current diversion and high-frequency electrical noise filtering while connected in parallel with a facility's distribution system. Utilize non-linear voltage dependent metal oxide varistors or selenium cells. For the suppression system's components, do not utilize gas tubes, spark gaps, or silicon avalanche diodes. Refer to the device as a TVSS filter for the purpose of this Specification and Drawings.

1.3 Shop Drawings and Product Data

.1 Submit Shop Drawings in accordance with Section 01300 – Submittals.

.2 Provide mounting details, dimensions, wiring diagrams and ratings for each type

2. PRODUCT

2.1 Operation and Environment

.1 Voltage: Use TVSS devices suitable for the voltage and systems configuration as indicated on the single line diagram(s).

.2 MCOV: Ensure the MCOV of the suppressor is greater than 125% for 120/208 V systems and 115% for 347/600 V systems.

.3 Protection Modes: Provide transient voltage surge suppression paths for all possible common and normal modes (between each line and ground, neutral and ground, line to line and each line and neutral). Ensure the primary suppression path is not to ground.

2.2 Suppression Component

Peak surge Current per Phase	240,000 A	(Main entrance panel applications)
	120,000 A	(Branch Panel Applications)
	30,000 A	(Plug-in / Cord -- connected individual equipment protection)
Let Through Voltage (L-N)	120 V (individual equipment units)	330 V
	208 V Units	500 V
	600 V Units	1200 V
TVSS clamping components response time	< 1 nanosecond	

2.3 Filtering

.1 TVSS: contain a high frequency extended range tracking filter.

.2 Noise attenuation ≥45 dB @ 1`00 kHz.

.3 Main entrance panel application effective filtering bandwidth - 180 Hz to 50 Mhz. Branch panel application effective filtering bandwidth - 1 kHz to 50 Mhz. Plug-in/Cord - Connected Individual Equipment application effective filtering bandwidth - 100 kHz to 100 Mhz.

2.4 Panelboard Component (Integrated TVSS Panel)

.1 Main Bus: copper, tin plated main bus.

.2 Circuit Breakers: over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.

.3 Panelboard Enclosure: Provide the panelboard in an EEMAC 1 enclosure. Configure the TVSS/filter status indicators to be visible without the need to open the panelboard door. Provide a lockable door to limit access to authorized personnel only. Make trim assembly tamper proof. Finish the trim (doors) in grey ASA61 paint.

.4 Neutral Bus: Equip with a copper 100% rated neutral bus, including a sufficient quantity at solderless type lugs to service the total unit circuit capacity.

.5 Wiring Gutters: Equip the integrated TVSS filtering panel with a complete perimeter wiring gutter with a cross-sectional dimensions of not less that 12,200 mm².

.6 Safety and Insulated/Isolated Ground Bus: Provide the integrated filter panel with a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

2.5 General Features

.1 Connectors: Provide terminals for all the necessary input and output power and ground connections on the TVSS.

.2 Enclosure: Provide the specified system in a heavy duty NEMA 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Ensure indication of surge current module status are visible without opening the door.

.3 Internal Connections: Make all surge current diversion connections by way of low impedance wiring. Wire surge current diversion components for reliable low impedance connections. Do not use plug-in component modules, quick disconnect terminals or printed circuit boards in surge suppression paths.

.4 Unit Status Indicators: Provide red status indicators on the hinged front cover to indicate unit phase status. Take the absence of the red light to reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.

.5 Fuses: Utilize internal fuses rated with a minimum interrupting capability of 2000,000 A or greater.

.6 Identification: Include Manufacturer's nameplate, ULc rating on the exterior enclosure.

.7 Warranty: Manufacturer to provide a five (5) year warranty on the TVSS filter, a two (2) year warranty on the panelboard and circuit breakers, and a two (2) year warranty on individual equipment plug-in units, all commencing upon Total Performance.

.8 Testing: Include assurance checks, "Hi-Pot" test at two times rated voltage plus 1000 V per ULc requirements, and operation and calibration tests.

2.6 Approved Manufacturers

.1 Current Technologies

-- Main panel application — Model MP
-- Branch panel application — Model DPA
-- Integrated TVSS panel — Model EGP
-- Individual Equipment Protection

.2 Liebert Corporation

-- Main panel applications Model LCG-C3
-- Branch panel applications Model LCG-C2
-- Integrated TVSS panel Model LPG

.3 Tycor International Corporation

-- Main panel applications Model PTY-HE
-- Branch panel applications Model PTY-SA
-- Individual Equipment Protection

.4 Schnieder/ Square D Model IMA

.5 Rayvos Model 347-3Y

.6 Siemens Model TPS-6

3. EXECUTION

3.1 Installation

.1 Supply and install with Manufacturer's recommended conductors tapped from the electrical service switchboard conductor system. Conductors are to be as short and straight as possible. Twist input conductors to the TVSS together to reduce impedance during high frequency filtering.

.2 Supply and install an appropriately sized manual safety disconnect before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS manufacturer.

.3 The TVSS should follow the manufacturer's recommended practices as outlined in the manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.

.4 Supply and install individual equipment protection devices at the same voltage rating as the intended protected equipment and as close as possible to the intended protected equipment.

END OF SECTION

CONTACTORS

1. GENERAL

1.1 Description

.1 Supply and install contactors as indicated on drawings and specified herein to ensure a complete operational system.

.2 This specification covers contactors for voltages up to 600 V. Refer to drawings for voltage, amperage, number of poles, and auxiliary contacts.

1.2 Product Data

.1 Submit product data in accordance with 01300 – Submittals.

2. PRODUCTS

2.1 Contactors

.1 Contactors: to EEMAC No.1CS.

.2 Mechanically held controlled by pilot devices as indicated and rated for type of load controlled. Base this rating on incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. For all contactors use 120V operating coils.

.3 Breaker combination contactor as indicated.

.4 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 1 unless otherwise indicated.

.6 Include the following options in cover:

.1 Red indicating lamp

.2 Stop-Start push-button

.3 Hand-Off-Auto selector switch

.7 Control transformer: To Section 16825 - Control Devices**,** in contactor enclosure.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Provide a nameplate indicating name of load controlled.

3. EXECUTION

3.1 Installation

.1 Install contactors and connect auxiliary control devices where indicated on drawings and specified herein.

.2 Mount contactors separately in suitable enclosures rated for the area in which they are to be installed.

END OF SECTION

GENERAL PROVISIONS FOR INTERIOR LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply and install lighting fixtures complete with lamps, ballasts and all necessary fittings.

1.2 Code Requirements

.1 Installation of lighting equipment to conform to Section 30, Canadian Electric Code, Part 1, and as amended or supplemented by provincial, municipal or other regulatory agencies having jurisdiction.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Submit a complete list of the types of lighting fixtures, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc. for review. Bind in a suitable booklet and keep one copy of this booklet at the Site at all times.

.3 Submit complete photometric data, based on actual fixtures proposed for project. Substantiate brightness and efficiency requirements. Photometric data must be produced by a recognized independent laboratory.

1.4 Manufacturer's Operational Test

.1 Test fixtures with rated lamps for starting and operation.

.2 Check wiring for agreement with design circuit.

.3 Test for short circuits and improper grounds.

.4 Test operation of fixture and lamp with ballast.

1.5 Plant Inspection

.1 A preliminary inspection of lighting fixtures and their components may be made at manufacturer's factory. Inform Contract Administrator of progress and various stages of manufacturing and arrange an appropriate time for inspection.

1.6 Lamps Used for Temporary Lighting

.1 Fluorescent or mercury lamps may be used for temporary light and lamps used for this purpose prior to Substantial Performance. Total Performance relamp faulty or burned out lamps prior to Substantial Performance at the Contractor’s cost.

.2 Metal halide, sodium, incandescent and quartz lamps are not to be used for temporary lighting, unless all lamps so used are replaced with new lamps immediately prior to completion at no additional cost to the City.

2. PRODUCTS

.1 Provide, wherever possible, commercially available stock lighting fixtures meeting specified requirements and as shown on the drawings.

.2 Different fixtures may be supplied by different manufacturers. Similar fixtures to be supplied by the same manufacturer.

.3 Provide only lighting fixtures which are structurally well designed and constructed and which use new parts and materials of highest commercial grade available. Unless otherwise specifically noted, fixtures to be of the quality stated in the manufacturer's catalogues and data sheets.

.4 Refer to related sections for details of fixtures and accessories.

.5 Use self-aligning ball joint hangers for rod suspended fixtures.

.6 Use cadmium plated chains for suspended fixtures in unfinished areas.

.7 Refer to Luminaire schedule on drawings for luminaire descriptions and acceptable manufacturers.

3. EXECUTION

3.1 Installation

.1 Install fixtures in accordance with the manufacturer's requirements, code requirements, and as shown on the drawings.

.2 Confirm compatibility and interface of other materials with luminaire and ceiling systems. Examine the room finish schedule and reflected ceiling drawings. Report discrepancies and defer ordering until clarified.

.3 Supply plaster frames, trim rings and backboxes to other Divisions as the work requires.

.4 Ground lighting equipment to metal raceway, armour of armoured cable, grounding conductor in non-metallic sheathed cable, or to a separate grounding conductor.

.5 Co-ordinate with contractors responsible for the work of other divisions to avoid conflicts between luminaires, supports and fittings and process, mechanical and structural equipment.

.6 Provide guards where fixtures are subject to mechanical damage as required by code or shown on the drawings.

3.2 Workmanship

.1 Completely clean all glassware, lamps, and hangers. Polish metal parts before completion.

.2 Provide suitable extension couplings for row mounted fixtures.

.3 Protect fixtures, hangers, supports, fastenings and accessory fittings at the Site prior to and during installation. Unless fixtures are erected immediately, after delivery to Site, deliver in original cartons or enclosed in air-tight plastic wrapping. Store in a dry and secure space on Site. Protect hangers, supports, fastenings and accessory fittings against corrosion. Take care during installation to ensure that insulation and corrosion protection is not damaged.

.4 Fixtures which show evidence of corrosion, rough handling, scratching of finishes, etc. are to be replaced with new fixtures at no additional cost to the City.

.5 Install recessed fixtures to permit removal from below, for access to outlet or prewired fixture box.

.6 Hang and mount fixtures to prevent distorting fixture frame, housing, sides or lens frame, and permit correct alignment of several fixtures in a row.

.7 Support fixtures as shown on drawings, level, plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted fixture housings rigidly and adjust to a neat flush fit with mounting surface.

.8 Adjust length of hangers of suspended fixtures to hang fixture bodies level and in same horizontal plane, unless shown otherwise on drawings.

.9 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

.10 For recessed fluorescent fixtures mounted in suspended ceiling with exposed tee bar grid system, support by the ceiling tee bar grid structure. Provide any additional support necessary for oversize fixtures, or to meet code requirements.

.11 For metal inserts, expansion bolts or toggle bolts accurately locate in relation to outlet boxes, for perfect alignment and spacing of suspension stems or other hangers.

.12 For remote mounted ballasts, supply mounting board and space ballasts in accordance with manufacturer's directions. Size wiring from ballasts to remote fixtures to meet manufacturer's requirements.

.13 Remove any noisy ballasts from the fixtures and replace at no additional cost to the City prior to completion.

END OF SECTION

LIGHTING EQUIPMENT

1. GENERAL

1.1 Documents

.1 This section of the specifications forms part of the Contract Document and are to be read, interpreted, and coordinated with all other parts.

1.2 Work Includes

.1 This section includes the supply and installation of luminaires complete with lamps, ballasts, supports, and accessories, and the supply of plaster frames, trim rings, and back boxes for plaster or drywall ceilings or concrete. Refer to the luminarie schedule on the drawings.

1.3 General Requirements

.1 Install lighting as shown on Electrical Drawings and as indicated in Contract Documents.

.2 Provide and install all materials, components, and services necessary for a complete wiring distribution system for lighting.

.3 Prepare all forms to show compliance with applicable energy use regulations.

1.4 Section Includes

.1 Interior and exterior light fixtures, fixture finishes, and accessories.

.2 Ballasts and transformers.

.3 Lamps,

.4 Lamp holders.

1.5 Reference Standards

.1 National Fire Protection Association (NFPA) Standard, current edition.

.2 Underwriters' Laboratories Canada (ULC).

.3 Illuminating Engineering Society of North America (IESNA).

.4 Canadian Standards Association (CSA).

.5 ANSI C82.4, Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.

.6 Heavy Phosphate Conversion Coatings for Iron and Steel (for Corrosion Resistance).

.7 Zinc Phosphate Conversion Coatings for Paint Base.

.8 Coating, Conversion, Iron Phosphate for Paint Base.

.9 Installation of lighting equipment to conform to the current edition of the Canadian Electrical Code as amended and supplemented by Provincial, Municipal, or other regulatory agencies having jurisdiction.

.10 Luminaires to conform to CSA C22.2 No. 9, ballasts to CSA C22.2 No. 74, ANSI C82.1.

1.6 Submittals, Shop Drawings, and Product Data

.1 Submittals

.1 Submit shop drawings, samples, and product data in accordance with Section 01300 - Submittals.

.2 Contractor is responsible for all verification and actual field dimensions, quantities, coordination, and compliance with Contract Documents.

.3 Submit ballast shop drawings with each applicable fixture shop drawing. If required by the Contract Administrator, submit certified heat run test data for each type of ballast mounting.

.2 Provide fully dimensioned shop drawings for all fixture types and all custom mounting hardware.

.1 Do not release orders for lighting equipment until review of submittals is complete.

.2 Submit shop drawings for all products as follows:

.1 Complete fully dimensioned detail drawings including all major components and details of fabrication.

.2 Requisite schematics and plans indicating assembly and installation of components.

.3 Inventory of all equipment to be supplied including types, quantities, and reference to applicable drawings and schematics.

.3 Submit a list of fixture types and quantities and catalogue cuts for all product data. Such data to show both technical and pictorial detail, marked specifically to show the optional or alternate components required, the exact catalogue number, and type designation corresponding to the type indicated in the Fixture Schedule. Include this data also with Maintenance Manual and the Contract Administrator’s review stamp.

.4 Clearly mark manufacturer's product data clearly to indicate all technical information that indicates conformance to all specified requirements in Contract Documents. Include the following information for all fixtures:

.1 Manufacturer's catalogue sheets of standard fixtures, indicating materials, gauges, dimensions, standard finishes available, weights, CSA approval of fixture, and manufacturer's catalogue sheets of lamping showing lamps to be provided with fixtures.

.2 Photometrics from an independent testing laboratory calculated according to IES standards. Photometrics include the following:

.1 For lighting fixtures used for general illumination:

.1 Candlepower distribution curve and table. Data in table to have vertical angles no greater than 10° increments (5°, 15°, 25°, etc.). All asymmetric distributions to have quadrants represented in 22.5° increments (parallel, 22.5°, 45°, … normal), or sufficient increments to fully describe asymmetric light distribution.

.2 Coefficient of Utilization (CU) tables.

.3 Zonal lumens stated numerically in 10° increments (5°, 15°, etc.), or smaller increments for narrow beam fixtures.

.2 For all other fixtures, provide candlepower distribution curve and table with minimum 10° increments (5°, 15°, etc.) or small ° increments for narrower distribution fixtures.

.3 For all downlights, provide Footlambert measurements off of reflector surfaces, which shall be equal to or less than specified.

.4 For floodlights: vertical and horizontal beam spread, beam lumens, beam efficiency, and complete photometric data. Computer printout for aiming angles.

.5 In each submittal, include complete ballast information on all fluorescent and HID fixtures.

.6 Indicate lamp designation, lamp manufacturer's name, beam spread and Centre Beam Candle Power (for the reflector lamps only), rated life, mean and initial lumen output, and colour temperature base.

.7 Mark any submitted fixture that differs in any manner from that scheduled as "exception", clearly indicate exact differences, include all manufacturers' product data as described, and show associated cost credit to the City. Provide samples for any proposed substitution upon request of the Contract Administrator.

.8 The equipment manufacturer to provide additional information or demonstrations as required by the specifier to demonstrate conformance with Part 2 of the Section. Additional information or demonstration shall only be required prior to submittal of final approval and as notified in writing by the Manufacturer, or should product to be delivered to the Site differ from materials described in final submittals or published product literature. All demonstrations are to be at a location, time, and in a manner coordinated with and approved by the Contract Administrator.

1.7 Installation, Operation, and Maintenance Data

.1 Submit under provisions of Section 01730 – Operations and Maintenance Manuals.

1.8 Delivery and Storage

.1 Individually wrap, seal and substantially crate equipment for shipment. Perform all handling and shipping in accordance with Manufacturer's recommendations. Store products in unopened cartons in a protected location.

2. PRODUCTS

2.1 General

.1 Provide all products with CSA labels or appropriate approvals for all mounting conditions.

.2 Provide lighting fixtures new and complete with mounting accessories, junction boxes, trims, and lamps.

.3 All products of the same specified type are to be of the same manufacturer.

.4 Fixture type catalogue number does not necessarily denote required mounting equipment or accessories. Provide all appropriate mounting accessories for all mounting conditions.

.5 For all fixtures, provide the appropriate frame that is compatible with the ceiling type into which they are installed. Verify all ceiling types at the shop drawing review.

.6 Provide appropriate accessories for proper mounting of all fixtures. For example, include plaster frames for plaster ceiling. For fixtures in rated ceiling, provide firestop protection as specified elsewhere. For fixtures suspended from ceiling, provide pendants or aircraft cables complete with accessories to complete the installation as indicated on the drawings.

.7 For recessed luminaries, use the pre-wired type with the junction box and, where applicable, the ballast forming an integral part of the assembly with satisfactory access.

.8 Provide only luminaires, which are structurally well designed and constructed, and which use new materials of the highest commercial grade available. Unless specifically noted otherwise, luminaires to be of the quality stated in the manufacturers' catalogues and data sheets. Design luminaires for adequate dissipation of ballast and lamp heat, and for seismic conditions as specified in Section 16010 – Electrical General Requirements.

.9 Luminaire bodies for corrosive areas to be non-metallic or epoxy-coated.

.10 Hinges, latches, and other exposed hardware to be non-metallic, or 316 stainless steel for corrosion-resistant luminaires. Use 316 stainless steel chains for suspension of corrosion-resistant luminaires.

.11 Where light fixture or light fixture suspension apparatus penetrates metal pan or sheet metal ceiling or canopies, provide an approved copy of the shop drawings of those fixtures to the ceiling manufacturer. Apertures in the ceiling or openings for suspension cables to be pre-cut by the ceiling manufacturer to suit light fixtures. Instruct the manufacturer accordingly.

2.2 Lamps

.1 Provide all fixtures with proper, new, and operable lamps. Provide lamps indicated on the Fixture Schedule, or, if not indicated, as recommended by the fixture manufacturer. Use lamps that are compatible with the respective fixture in all cases.

.2 Provide all fluorescent lamps by one manufacturer. Provide all coated metal halide lamps by one manufacturer. Provide all clear metal halide lamps by one manufacturer. Provide all HQ1 metal halide lamps by one manufacturer. Provide all incandescent, including tungsten halogen lamps, by one manufacturer.

.3 Unless otherwise specified, use 130V, extended service lamps.

.4 Use extended lite incandescent A-lamps unless otherwise specified. Lamps using diode technology will be unacceptable unless otherwise specified. For all quartz sources, provide a tempered glass shield of minimum 3 mm thickness either integrated within the lamp or the fixture.

.5 For all line voltage halogen lamps, provide spiral lenticular lenses to ensure smooth beam pattern. Use lamps rated at least 2500 hours. Do not use lamps containing lead solder.

.6 Use tri-phosphor, rapid-start fluorescent lamps with 3500° Kelvin colour temperature, unless noted otherwise in the Fixture Schedule. For all fluorescent lamps of the same type and colour, use Philips low mercury content type.

.7 Unless otherwise specified for all T8 fluorescent lamps, use "low energy" 32 WT8 3500°K for 1220 mm (48") lamps with minimum CRI of 80, 'premium' quality unless specified by the Fixture Schedule, use Philips low mercury content type. Include

allowance for change of fluorescent lamp colour in this Contract. Final lamp colour will be determined during shop drawing review of light fixtures.

.8 For all T5 and T5 HO lamps, use tri-phosphor rapid-start with 3500° Kelvin colour temperature as manufactured by Philips.

.9 For compact fluorescent triple tube lamp, use 3500°K unless otherwise specified in the Fixture Schedule. Lamp manufacturer for this item will be named after fixture manufacturer is selected and will be based on light fixture photometric details. Include allowance for change of fluorescent lamp colour in this Contract. Final lamp colour will be determined during shop drawing review of light fixtures.

.10 For all compact fluorescent double and quad tube lamps, use 3500°K unless otherwise specified in the Fixture Schedule, manufactured by General Electric, Osram/Sylvania, or Philips. Include allowance for change of fluorescent lamp colour in this Contract. Final lamp colour will be determined during shop drawing review of light fixtures.

.11 For all metal halide sources, use warm colour temperature, i.e., 3000° - 3200°K, unless otherwise specified in the Fixture Schedule. Replace metal halide lamps deemed to have excessive colour variation by the Contract Administrator. Acceptable manufacturers: General Electric, Osram/Sylvania, Venture Lighting, or Philips.

.12 For all low voltage metal halide lamps, up to and including 100 watt, use ceramic arc tube consistent colour, 3000°K as Philips Mastercolor.

2.3 Lamp Holders

.1 Provide lamp holders that hold lamps securely to prevent damage caused by normal vibration and maintenance handling.

.2 For incandescent and high intensity discharge lamp holders, provide porcelain body, solid nickel or nickel-and-silver-plated contact, and socket with pre-lubricated silicone compound.

.3 For fluorescent lamp holders, provide a white urea plastic body and silver-plated phosphor bronze or beryllium copper contacts.

2.4 Ballasts and Transformers

.1 Fluorescent Ballasts

.1 Use fluorescent ballasts that are capable of operating lamps indicated on Fixture Schedule at full light output. Secure ballasts by screws; slip-in is not be acceptable. For all ballasts within a single fixture, provide by one manufacturer.

.2 Equip all fluorescent lighting fixtures with high power factor, solid state, electronic ballasts (minimum of 0.95 lagging power factor), thermally protected, constant wattage design, and manufactured to perform in accordance with CSA Specification C82.1 with regard to light output, regulation, and other operating characteristics.

LIGHTING EQUIPMENT

.3 Use ballasts complying with all applicable energy codes. Standard efficiency ballasts may be used whenever fixtures will be dimmed, a -20° Celsius temperature rating is required, or when "standard ballast" is specifically indicated in the Fixture Schedule.

.4 Unless noted otherwise, for all fluorescent ballasts, use solid state, electronic type Osram/Sylvania, Philips Mark V or Magnetek meeting the following criteria:

.1 A 0.87 minimum ballast factor unless noted otherwise.

.2 Ballast sound levels not exceeding Class A ambient noise levels. Replace noisy ballasts at no additional cost as directed by the Contract Administrator.

.3 Use ballasts CBM certified by ELT and ULC listed, Class P.

.4 Use ballast capable of operating one (1), two (2), three (3), or four (4) nominal 1220 mm (48"), or one (1) or two (2) biaxial rapid start lamps or other lamps as indicated on the Fixture Schedule. Two lamps may be connected in tandem to a single two-lamp ballast for the one-lamp linear architectural fluorescent fixture. In some cases ballasts may be required to operate two lamps of different lengths.

.5 Use ballast containing integrated electronic circuits, incorporating silicon chip to monitor incoming voltage and produce light output with less than 10% fluctuation from over input voltages from 90 to 145 volts, or 330 to 370 volts.

.6 Voltage rating to be the same as the circuit that supplies the lighting fixture, which uses the ballast.

.7 Totally encased and designed for 40° ambient temperature.

.8 Power factor: minimum 95% with 95% of rated lamp lumens.

.9 In magnetic "standard" ballast, use thermally protected capacitor.

.10 In magnetic "standard" ballast, use non-resetable thermal protection on coil.

.11 Harmonics: 10% maximum THD, including 49th for electronic discrete and hybrid ballast 25% maximum TDH, including 49th for electromagnetic ballast.

.12 No polychlorinated biphenyls (PCBs) will be permitted.

.13 Use ballast meeting FCC standbox for EMI/RFI (FCC Part 18, 15J), to reduce electromagnetic interference.

.14 Match electronic ballast to the lamp and number of lamps specified, i.e., do not use 2-lamp ballast to operate single lamp fixtures, etc.

.15 Provide low temperature T8/HO starting Ballast capable of starting at -17°C (0°F) for exterior fixtures.

.16 Ensure ballast case temperature does not exceed 25°C temperature rise over 40°C ambient.

.17 Use ballasts with a frequency of operation of 20 kHz or greater, and that operate without visible flicker (less than 15%).

.18 Design ballast in accordance with applicable ANSI Ballast/Lamp Specifications. Ensure power factor is not less than 95% and that ballast crest factor does not exceed 1.7.

.19 Except for instant start type ballasts, filament voltage to be 2.5V to 4.5V, inclusive.

.20 Starting characteristics must comply with ANSI C82.1. Ballast start to be soft, whereby the lamp electrodes are brought to emission temperature before the lamp ignites. Design the pre-heat time to be at least 0.4 seconds, with a glow current not exceeding 20 milliamps.

.21 Use ballasts providing auto surge protection to withstand line transients as defined in ANSI C62.41 Category A.

.22 The fundamental ballast frequency is 60 Hz.

.23 Lamps controlled by electronic ballasts must provide the same illumination level, within 5% compared to using to standard magnetic ballast.

.24 Ensure generation of multiple voltage/current, of the fundamental frequency (harmonics), meet all ANSI recommendations.

.2 High Intensity Discharge Ballasts

.1 Unless otherwise noted, use a make of ballasts for high intensity discharge (HID) lighting fixtures as recommended by the fixture manufacturer, compatible with the lamp specified. The manufacturer to be responsible for the performance of the integrated unit (ballast and lamp).

.2 For high intensity ballasts, use encased and potted quiet type unless otherwise noted.

.3 For ballasts for indoor and non-weatherproof, use UL listed Type 1. For ballast for outdoor use, utilize UL listed Type 2.

.4 Use ballast with high power factor (minimum 0.90 lagging power factor) with minimum 95% rated lumens.

.5 Use ballast of constant wattage, auto-transformer type, or constant wattage type.

.6 Ensure ballast is suitable to operate at ±10% voltage fluctuation.

.7 Ballast drop-out voltage: 66% of normal.

.8 Temperature requirements:

.1 For ballasts mounted in indoor-heated or air conditioned spaces, provide with temperature rating of 10°C to 40°C ambient temperature.

.2 For ballasts mounted in unheated spaces, provide with temperature rating of -30°C to 40°C ambient temperature.

.9 Ballast insulation: Class H, 190°C.

2.5 Fixture Construction

.1 General

.1 Use fixtures free of inappropriate light leaks.

.2 For recessed pot light type fixtures in non-accessible ceilings, provide accessible junction boxes, ballasts, and transformers through fixture apertures.

.3 Ensure metal clips, screws, angles, etc. are not visible when the fixture is viewed from below.

.4 Galvanize all mounting frames installed in damp locations or in plaster ceiling.

.5 Extruded fixture housings: a minimum thickness of 2.3 mm (3/32") and be smooth and free of tooling lines. Die cast end plates and joiner sections: a minimum thickness of 2 mm (3/32") thickness and concealed fasteners.

.6 Ensure die casts are smooth, free of pits, grooves, and imperfections.

.7 Ensure spinning are smooth and clean with finished edges, and free of spinning lines.

.8 Use sheet metal fixture housings of welded construction with seams filled and ground smooth. Note any exceptions under individual fixture types.

.9 For all adjustable fixtures, provide locking rotation and tilt devices.

.10 For pendant-mounted fixtures, provide stems with ball swivels or be cable-mounted to allow 45 degrees swing in any direction from vertical.

.11 Conceal ball swivels and cable end hardware with sleeve.

LIGHTING EQUIPMENT

.2 Reflector Cones

.1 Provide 45 degrees lamp image cut-off when viewed from below unless indicated otherwise.

.2 Reflector cones: a minimum thickness of 0.8 mm (0.03125") and manufactured of uniform gauge Alcoa 3002 alloy, free of spin marks, or other manufacturing defects. Do not use plastic for cones or trim rings

.3 Use semi-specular reflector finish by means of an Alzak process. Ensure reflector inner surface is free of water spotting and maintains a reflectivity ratio of no less than 80% on clear specular finish unless otherwise noted.

.4 Form cone flange as an integral part of the cone with an identical appearance as the inner cone unless otherwise indicated. Use flange overlap with a perpendicular orientation to the cone, and with adequate width to cover the ceiling opening with no visible light leaks.

.5 Furnish fixtures with Alzak reflector cones by the same manufacturer, unless otherwise indicated. Provide all reflector cones with iridescent suppressant finish for fluorescent and HID fixtures unless otherwise specified.

.3 Parabolic Louvre Assemblies

.1 Ship and store louvre assembles in plastic bags and do not be install until construction has progressed to a suitable clean stage. Single piece peel-off seal on bottom of the louvre is not acceptable. Do not allow construction dust or paint to accumulate on the louvres at any time. Construct louvres with minimum 0.6 mm (0.0235") Alcoa licensed process Coilzak semi-specular iridescent suppressant anodized aluminum. For all louvre blades, use parabolic designed curvature. All cell sizes: equal unless otherwise specified.

.4 Unless otherwise noted, lenses for use with fluorescent fixtures - minimum 3.175 mm (0.125") thickness. For all ceiling-mounted or recessed fluorescent fixtures with plastic lenses.

.1 Material - light-stable, UV-stabilized 100% virgin acrylic with minimum 98% transmittance unless otherwise indicated. Use acrylic conforming minimum standards of IES-NEMA-SPI, a minimum thickness of 3.175 mm. Use material that performs as applied for a period of 20 years with no greater than 5% transmission loss.

.5 Parabolic Baffles

.1 Ensure all parabolic baffles are straight and paralleled with equal cell sizes. For baffles placed end to end, ensure there is no visible break in appearance. Construct baffles with a minimum of 0.6 mm (0.235") Alcoa licensed process Coilzak semi-specular iridescent suppressant anodized aluminum unless otherwise specified.

.6 Multi-grove Baffles

.1 All multi-grove baffles - one piece seamless aluminum with sharply detailed concentric rings. For baffles placed end to end, ensure there is no visible break in appearance. Permanently fasten baffles to the specular parabolic reflector. Baffles to be black unless otherwise specified.

2.6 Fluorescent Fixtures

.1 Manufacture fluorescent fixture housings from minimum #20 gauge CR steel.

.2 Do not use fixture housing with pressure fit construction or utilizing rivets, when applicable, incorporate lenses in hinged frame utilizing hidden release mechanism of a heavy duty standard (i.e., visible frame releases will not be accepted). Securely retain lenses in the frame assembly utilizing the equivalent of stainless steel piping clips.

.3 Finish fixture reflectors, unless specifically designed using specular metal, with a complete coverage of white alkyd reflecting enamel. Use enamel with a minimum 85% reflectivity, applied by either an electrostatically charged spray or dip process, then baked in a temperature controlled oven until paint is thoroughly cured. Prior to applying enamel, prepare each metallic surface using a five-stage, hot zinc phosphatizing process.

.4 For all fluorescent fixtures, stencil the following wording above each lamp, visible only when the lamp is removed: "RE-LAMP ONLY WITH (…TYPE…) LAMPS". Type - include colour, temperature, and lamp series.

.5 All painting to be done after cutting.

2.7 Recessed HID/Compact Fluorescent/Incandescent Fixtures

.1 For recessed HID, compact fluorescent or incandescent fixtures, use integral thermal protection and ensure fixture is ULC listed in category IEZX, incandescent recessed fixtures, except:

.1 Fixtures identified for use and installed in poured concrete.

.2 Listed recessed fixtures that are identified as inherently protected by construction design.

.2 Housing

.1 Interior fixture housings - a minimum gauge thickness of No. 20 for steel and No. 16 for aluminum.

.2 Exterior fixture housings - a minimum gauge thickness of No. 18 for steel and No. 14 for aluminum.

.3 Provide safety devices for removable fixture elements, (cones, louvres, lenses, etc.). Design safety device to support element while out of normal operating position and

to be removable. Ensure safety device does not interfere with normal operation of fixture.

2.8 Fixture Finishes

.1 Baked Enamel Finish:

.1 Conditioning of metal before painting:

.1 For corrosion-resistance conversion coating..

.2 For paint base, conversion coating.

.2 Finish metal surfaces of luminaire housing and reflectors with high gloss polyester powercoat or alzak aluminum to give smooth, uniform appearance, free from pinholes or defects.

.3 Finish reflector and other inside surfaces as follows:

.1 White minimum reflection factor 85%.

.2 Colour fastness: yellowness factor not above 0.02 and after 250 h exposure in Atlas fade-ometer not to exceed 0.05.

.3 Film thickness not less than 0.03 mm average and in no areas less than 0.025 mm.

.4 Gloss not less than 80 units as measured with Gardner 60° gloss meter.

.5 Flexibility: withstand bending over 12 mm mandrel without showing signs of cracking or flaking under 10 times magnification.

.6 Adhesion: 24 mm square lattice made of 3 mm squares cut through film to metal with sharp razor blade. Adhesive cellulose tape applied over lattice and pulled. Adhesion satisfactory if no coating removed.

.2 Finish painted fixtures with synthetic enamel, with acrylic, alkyd, epoxy, polyester or polyurethane base applied after the fixture is completely constructed. Use light stabilized, baked on at minimum 180°C, and catalytically or photochemically polymerized after application.

.3 Clean and treat all metal parts with phosphate or chromate bonding process after fabrication for maximum paint adhesion.

.4 For all polished decorative metals (brass, chrome, etc.), use a clear protective finish, baked-on lacquer or air-cured urethane.

.5 All custom colour finishes are to be approved by Contract Administrator.

.6 For all fixtures, lenses, diffusers, and fittings ensure a flame spread rating is less than 250. Shop drawings are required.

2.9 Lighting Fixture Schedule

.1 Catalogue numbers in the Lighting Fixture Schedule are shown to indicate approved manufacturer and fixture quality requirements. The numbers may or may not include variations or special light fixture features as specified in the associated fixtures. Include all features as specified in the Schedule.

2.10 Wire Guards

.1 Provide wire guards to all fixtures that are mounted so that any part of the fixture is less than 2400 mm (8'-0") above adjacent floor, unless noted otherwise in the Fixture Schedule.

.2 For all fixtures in storage rooms and service rooms, provide wire guards.

3. EXECUTION

3.1 Verification of Conditions

.1 Confirm all ceiling depths against the final architectural ceiling plans and sections to ensure that recessed fixtures can be installed in all ceiling conditions and advise the Contract Administrator immediately of any discrepancies prior to ordering of the fixtures or proceeding with the work. Prior to order of modified fixtures for non-standard ceiling depths, confirm with the Contract Administrator.

3.2 Installation – General

.1 Install lighting fixtures as indicated on architectural reflected ceiling plans, Electrical Drawings, and per approved shop drawings.

.2 Lighting fixtures are indicated in the Lighting Fixture Schedule by means of type numbers that correspond to similar numbers on the plans.

.3 Install lighting fixtures in accordance with fixture manufacture's written instructions, applicable requirements of CEC, applicable authorities, and with recognized industry practices.

.4 Verify locations and spacing of lighting fixtures with reflected ceiling plans and notify Contract Administrator of any variance or conflict between the plans and field conditions. Do not proceed until conflict has been resolved.

.5 Coordinate work with Contractors. Lighting fixture locations shall have priority over locations of ducts, diffusers, sprinklers, smoke detectors, and other non-structural obstructions. Notify Contract Administrator of any conflicts and do not proceed with installation until conflicts are resolved.

LIGHTING EQUIPMENT

.6 Support all fixtures directly from the building structural members or from bridging attached to the structural members by rod hangers and inserts. Provide all necessary hardware and blocking to ensure that fixtures hang true.

.7 Install recessed luminaires to permit removal from below, unless noted otherwise, to gain access to outlet or pre-wired luminaires box. Make final connection from boxes to luminaires with flexible conduit. The flexible connection will not exceed 2 metres.

.8 For recessed luminaires, in particular for HID pot-lights and fluorescent luminaires, support luminaires independent of suspended ceiling system.

.9 Where fluorescent luminaires are surface-mounted on T-bar ceilings, support unit from structure and stabilize luminaires with sheet metal screws to a T-bar at both ends.

.10 When fluorescent luminaires are installed in valances with solid lines, ensure presence of adequate ventilation openings into ceiling space to dissipate heat.

.11 Equip fixtures installed in suspended T-bar ceiling with T-bar clips. Securely fasten clip to suspended T-bar ceiling system framing members. Centre the light fixture in the ceiling grid opening. Provide a minimum of two clips, on each on diagonal opposite corners, and provide more clips if required by local authority having jurisdiction. Incorporate reusable clips, not closed down with rivets.

.12 Provide every light outlet in the building with a lighting fixture as instructed, complete with lamps and other accessories necessary for its proper installation and operation. If a fixture type is not designated for any particular outlet, obtain the necessary details from the Contract Administrator. Alternatively, supply a suitable fixture for the outlet involved as directed by the Contract Administratorss.

.13 Effectively ground all fluorescent fixtures. Fixtures with their sockets so far apart as to give less than perfect contact at the lamps, or with poor grounds, will be rejected and replaced by the Contractor without charge.

.14 For exact location of ceiling mounted lighting fixtures in T-bar ceiling areas, refer to Architectural reflected ceiling plan. These plans will be provided by the Contact Administrator prior to installation.

.15 Install lighting fixtures true to the surface in or to which they are mounted, and except where otherwise indicated on the Drawings, align correctly with building or room walls as the case directs. Mount wall fixtures at elevations specified or as shown on Architectural or Electrical Drawings. Where no elevation is shown, confirm mounting height with the Contract Administrator prior to rough-in.

.16 Where lighting fixtures are stem hung from “ball and socket” swivels at the ceiling, use stranded wire, #14AWG (19 x 29) minimum size, from outlet box to the fixture.

.17 Where lighting fixtures are chain-suspended, use solid conductor in armoured cable or flexible conduit and secure to the chain with white or clear nylon cable ties, as specified elsewhere.

.18 Ensure all parts of all fluorescent and high intensity discharge lighting fixtures are securely fastened, and if necessary, fitted with neoprene spacers to minimize ballast noise amplification.

.19 Install all fixtures with the bottom of the fixture housing aligned with the finished ceiling line unless otherwise noted in the manufacturer's installation instructions.

.20 Ensure ceiling insulation is a minimum of 75 mm (3") away from fixture.

.21 Support recessed fluorescent fixtures by four hangers per fixture minimum independent of ceiling structure or tee bars unless ceiling system is designed to carry the fixtures. In this case, provide seismic restraints only.

.22 Support recessed compact fluorescent by one hanger per fixture minimum independent of ceiling structure or tee bars.

.23 Provide wiring channel for mounting of fluorescent fixtures and wiring in between fixtures, suspended below mechanical piping, ductwork, etc., as directed on 13 mm (0.5") rigid conduit or 10 mm (0.4") galvanized rod hangers, on 2440 mm (8 ft.) centres.

.24 Nominal size of channels 70 x 70, 10 mm (0.4") steel minimum, baked white enamel finish, complete with channel connectors, and closure pieces, coverpieces, mounting hickeys, fixture connectors, etc., with jointer pieces 300 mm (12") in length minimum to form a rigid assembly.

3.3 Workmanship

.1 Provide suitable extension couplings for wall-mounted luminaires.

.2 Handle and mount luminaires to prevent distorting frame, housing, sides, or lens frame and permit correct alignment of several luminaires in a row.

.3 Support luminaires as indicated on the Drawings, level and plumb, and turn with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted luminaire housing rigidly, and adjust to neat flush fit with mounting surface.

.4 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hangar.

.5 Where luminaires are required to be supported from the building structure, use a minimum of two 6.35 mm rods per luminaire, four rods for luminaires 610 mm wide or wider.

.6 Apply a protective coat of bituminous paint to surfaces of recessed luminaires, which are in contact with concrete.

3.4 Installation of Recessed Fixtures

.1 Cut holes to exact fixture size so that no gaps will be present when trims or cones are installed.

.2 Cut round holes in acoustical tile ceilings using adjustable diameter cutter on slow speed drill press.

.3 Provide plaster frames or plaster trim as required and turn same over to the ceiling section for installation.

.4 Install trims tight with no gaps or light leaks. Install reflector cones, baffles, aperture plates, and decorative elements after completion of plastering, ceiling tile work, painting, and general clean up in areas. Do not caulk or seal fixture trim cones to ceiling to eliminate light leaks or gaps.

.5 Where fixtures are recessed into non-accessible ceiling and the fixture specified are not pre-wired, wire to an outlet box adjacent to each fixture and visible only when the fixture is removed, connect to the fixture with suitable high-temperature wire in at least 1200 mm (48") of flexible conduit. Install fixtures so that they may be readily removed to gain access to these outlet boxes.

.6 Provide site-fabricated insulation shields over all recessed lighting fixtures without insulation rated housing installed in ceilings above areas where thermal insulation is to be installed. Construct shields of a size and material acceptable to the Electrical Inspector.

3.5 Installation of Linear Fixtures

.1 Linear fixtures, surface mounted or suspended - maximum 6 mm (1/4") variation in alignment for any 5 metre (17 foot) run.

3.6 Installation of Track Lighting

.1 In spaces with parallel rows of track, install all track in such a manner that neutral conductors and feeds have the same orientation.

3.7 Installation of Lamps and Ballasts

.1 Ensure that, at the time of occupancy of any area, all lamps within that area are in proper place and working order. Replace high intensity discharge lamps and long-life exit sign lamps, which fail after this time until the expiration of the warranty. All other lamps to be the responsibility of the City dating from Total Performance for the area involved.

.2 Should the Contractor request and receive approval to use the new permanent lighting fixture system (fluorescent only) for construction purposes (i.e., temporary lighting) and

the use of the permanent fixtures is prior to Total Performance, provide (supply) replacement lamps to the City as follows:

.1	60 – 150 days	10% of total lamps involved
.2	151 – 250 days	20% of total lamps involved
.3	251 – 350 days	50% of total lamps involved
.4	351 - 450 days	100% of total lamps involved
.5	451+ days	not applicable Contractor to re-lamp (supply and install) all fixtures.

.3 Provide 2% of the total quantity of spare lamps of all types over to the City (obtain receipt and submit same to the Contract Administrator).

.4 Replace noisy ballast at the Contractor's expense. The decision as to what constitutes a noisy ballast rests solely with the Engineers.

.5 Ensure all fluorescent amalgam and metal halide lamps are continuously burned for 100 hours when first turned on.

3.8 Field Quality Control

.1 Operate each fixture after installation and connection. Each fixture to be inspected for proper connection and operation.

.2 Perform testing of operation of temporary or emergency power systems.

.3 Verify that all lenses, louvres, baffles, fixture trim cones, diffusers, and other parts are thoroughly cleaned in a manner recommended by the manufacturer.

.4 Replace all lamps used during construction with new lamps prior to Total Performance.

3.9 Branch Circuit Wiring

.1 Where the Drawings do not show conduit routing or conduit sizes and wire counts, supply and install a complete system of conduit and wire for the lighting system. Make all connections and install all conductors for the switching and branch circuiting indicated and required. Run conduit parallel to major building lines.

.2 Conductors - #12R90 XLPE minimum.

.3 Provide a neutral for each circuit (phase conductor).

.4 Size conduits in accordance with code requirements for wire count installed. Do not use conduit less than 19 mm for home runs. Base conduit fill on maximum of six phase conductors per conduit, resulting in a derating of 70% as per Canadian Electrical Code.

LIGHTING EQUIPMENT

3.10 Fixtures in Service Rooms

.1 Before mounting any fixture in mechanical, electrical, or other service rooms, obtain written approval of layout to be used. Coordinate layout with mechanical ductwork and piping or wireways to suit equipment limitations in the room.

3.11 Adjustments

.1 Coordinate with Section 01670 - Commissioning.

.2 Aim all adjustable fixtures as instructed by the Contract Administrator. Provide personal, lifts, and ladders, as required. Contractor to advise Contract Administrator two weeks in advance of scheduled aiming.

.3 Adjust exit sign directional arrows, if required.

3.12 Cleaning

.1 Remove all plastic bags form parabolic fixtures after construction is finished and prior to final acceptance.

.2 Remove all equipment, materials, wiring, and fixtures from those areas affected by the construction. Remove materials that are not part of the lighting or electrical distribution system from the Site.

.3 Clean all lighting fixtures in a manner approved by the manufacturer, to be free of dirt and debris upon completion of installation.

3.13 Demonstration

.1 Coordinate with Section 16990 – Electrical Equipment and Systems Demonstration and Instruction and Section 01664 – Training

.2 Train building personnel to operate lighting control system. Advise building personnel on relamping procedures and given a list of lamps required for the fixtures supplied in performance of the Work.

3.14 Protection

.1 Once installed, protect lighting fixtures from damage during the remainder of the construction period.

3.15 Warranty

.1 Provide Contract warranties as well as Manufactuer’s warranties for 24 months after Total Performance.

.2 Solid state electronic ballasts: extended warranty period of 5 years.

.3 Non-solid state electronic ballasts: extended warranty period of 36 months.

END OF SECTION

EXIT SIGNS

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit duct data in accordance with Section 01300 – Submittals.

2. PRODUCTS

2.1 Standard Units

.1 Housing: extruded aluminum housing, brush aluminum finish.

.2 Face and back plates: extruded aluminum.

.3 Lamps: LED-2W Unit - 120 V.

.4 Operation: designed for 25 years of continuous operation without relamping.

.5 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red on die-cast aluminum face, reading EXIT.

.6 Downlight: translucent acrylic in bottom of unit.

.7 Face plate to remain captive for relamping.

.8 Universal mounting.

.9 Integral ½ hr. battery backup

3. EXECUTION

3.1 Installation

.1 Install exit lights.

.2 Connect fixtures to exit light circuits.

.3 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply emergency lighting units complete with all accessories.

1.2 Special Codes

.1 Canadian Electric Code, Part 1, Section 46 "Emergency Systems, Unit Equipment and Exit Signs".

.2 CSA Standard C22.2 No. 141 "Unit Equipment for Emergency Lighting".

.3 Building Code

1.3 Shop Drawings and Product Data

.1 Submit product data in accordance with Section 01300 – Submittals.

.2 Data to indicate system components, mounting method, source of power and special attachments.

2. PRODUCTS

2.1 General

.1 Supply and install battery power emergency lighting where shown on the drawings. Lights are to switch "ON" automatically in the event of failure of normal power, and "OFF" on restoration of power. Use the batteries that automatically recharged from a 120 VAC supply.

2.2 Equipment

.1 Supply voltage: 120 V, ac.

.2 Output voltage: 12 V dc.

.3 Operating time: 60 min.

.4 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

.5 Solid state transfer circuit.

.6 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.7 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.8 Lamp heads: integral on unit and remote as indicated, 345° horizontal and 180° vertical adjustment. Lamp type: tungsten, 9 W.

.9 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.10 Auxiliary equipment:

.1 Ammeter

.2 Voltmeter

.3 Test switch

.4 Time delay relay

.5 Battery disconnect device

.6 AC input and DC output terminal blocks inside cabinet

.7 Bracket

.8 Cord and plug connection for AC

.9 RFI suppressors.

2.3 Line Connection

.1 Hard wire each battery unit to an outlet box.

2.4 Units

.1 Units to contain solid state battery charger, transfer switch and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, "ON" and "charging" lights with extended lamp life.

2.5 Batteries

.1 Unless specifically indicated, provide batteries of sufficient watt-hour capacity to power the loads connected to each individual unit for 60 minutes, 12 volt, long life, maintenance free, sealed lead acid batteries, contained within the units.

2.6 Wire Guard

.1 Where indicated provide substantial wire guards with chrome finish, for battery units and/or lamps.

2.7 Wiring of Remote Heads

.1 Conduit: type to Section 16111 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Conductors: type to Section 16125 – Wires, Cables and Hardware up to 1000 V, sized in accordance with manufacturer's recommendations.

3. EXECUTION

3.1 Installation

.1 Mount battery units with the bottom of the enclosure not less than 2.2 m above the floor, where practicable.

.2 Where applicable wire from unit to third (DC) lamp in exit lights.

.3 Size wiring from units to remote heads and/or exit lights to prevent voltage drop of more than 5%.

.4 Properly aim all emergency heads.

3.2 Extended Warranty

.1 For batteries, the 12 months warranty period is extended to 120 months from date of Total Performance, with a no-charge replacement during the first 5 years and a pro-rate charge on the second 5 years.

END OF SECTION

UNINTERRUPTIBLE POWER SYSTEMS STATIC

1. GENERAL

1.1 Description of System

.1 System to consist of:

.1 Rectifier cubicle

.2 Inverter cubicle

.3 Battery cubicle

.4 Bypass switch cubicle

.5 Controls and meters

.2 System to use normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

.3 Equipment to operate continuously and unattended.

.4 Ensure that UPS is compatible with equipment that it feeds.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Include:

.1 Outline sketch showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

.2 Shipping weight.

.3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.

.4 Description of system operation, referenced to schematic diagram, for:

.1 Manual control during initial start-up and load transfer to bypass and back to inverter output.

.2 Inverter.

.3 Bypass.

.5 System performance and reliability:

.1 Consider any deviation from the required output power waveform as a failure in the UPS and include an estimate, with supporting calculations, of the Mean Time Between Failures (MTBF) expressed in hours.

.2 Provide an estimate with supporting data for the Mean Time to Repair factor (MTTR).

.6 Full load kVA output at 0.8 power factor.

.7 Efficiency of system at 25%, 50%, 75% and 100% rated load.

.8 Type of ventilation: natural or forced.

.9 Battery:

.1 Number of cells.

.2 Maximum and minimum voltages.

.3 Type of battery.

.4 Type of plates.

.5 Catalogue data with cell trade name and type.

.6 Size and weight of each cell.

.7 Cell charge and discharge curves of voltage, current, time and capacity.

.8 Derating factor for specified temperature range.

.9 Nominal ampere hour capacity of each cell.

.10 Maximum short circuit current.

.11 Maximum charging current expected for fully discharged condition.

.12 Recommended low voltage limit for fully discharged condition.

.13 Expected life.

.10 Inverter:

.1 Type and catalogue number.

.2 DC current at minimum battery voltage to produce full load AC output.

.11 Rectifier:

.1 Type and capacity, with catalogue number.

.2 Battery charging sequence.

.3 Current-time data for SCR protective devices.

.4 Guaranteed noise level.

.5 Estimated life.

.6 Metering.

.7 Alarms.

.12 Manufacturer's field experience with uninterruptible power systems of similar ratings including engineering expertise, manufacturing facilities and listing of UPS units manufactured and installed during last 5 years including model, customer, location and installation dates.

.13 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.

.14 Cooling air required in m3/s.

.15 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

.16 Typical operation and maintenance manual.

.17 Description of factory test facilities.

.18 Manufacturer's maintenance capabilities including:

.1 Willingness to undertake maintenance contract.

.2 Number of trained personnel available.

.3 Location of trained personnel and repair facilities.

1.3 Operation and Maintenance Data

.1 Provide data for incorporation into operation and maintenance manual specified in Section 01300 –Submittals.

.2 Submit interim copies to Contract Administrator prior to notification of factory test date.

.3 Operation and Maintenance Manual to include:

.1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.

.2 Technical data:

.1 Characteristic curves for automatic circuit breakers and protective devices.

.2 Project data.

.3 Technical description of components.

.4 Parts lists with names and addresses of suppliers.

1.4 Maintenance Materials

.1 Provide any specialty tools and materials required for proper maintenance of the UPS Equipment.

.2 Include:

.1 Four sets of each type and size of fuses used.

.2 Four sets indicating lamps.

.3 Spare parts provided.

1.5 Care, Operation, and Start-Up

.1 Arrange with Contract Administrator:

.1 For Manufacturer's Rep to provide support start-up of system, checking, adjusting and testing on Site.

.2 For instruction of operating and maintenance personnel on theory, construction, installation, operation and maintenance of system:

.1 After installation and during Site testing.

.2 At factory during shop testing.

.2 Advise on:

.1 Expected failure rate of equipment

.2 Type of expected failures

.3 Estimated time between major overhauls based on 20 year equipment life.

.4 Estimated cost of major overhaul based on current costs and excluding travelling expenses.

.5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

1.6 Delivery and Storage

.1 Crating:

.1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.

.2 For tractor train or sea shipment, use double layer of vapour barrier and 19 mm plywood covering.

.3 Subassemblies may be packed separately.

.4 Label crates:

.1 Shipping address.

.2 Weight and dimensions.

.3 Serial number of unit and brief description of contents.

.4 Stenciled with durable paint on at least two sides of each crate.

.5 List of contents:

.1 In weatherproof envelope stapled on outside of each crate.

.2 Copy placed inside each crate.

1.7 Source Quality Control

.1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested in presence of Contract Administrator.

.2 Notify Contract Administrator:

.1 One week in advance of date of factory test.

.2 That system has had preliminary testing and has met design requirements satisfactorily.

.3 Test procedures:

.1 Prepare blank forms and check sheet with spaces for recording data.

.2 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach meter recordings.

.3 Provide Engineer's signature on form to indicate concurrence in results reported.

.4 Duplicate given to Contract Administrator at end of test.

.5 Information from original presented as part of O&M Manual.

.4 Test equipment:

.1 Indicating and recording instruments to satisfaction of Contract Administrator.

.2 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate, or calibrated in presence of Contract Administrator against instruments which have calibration certificates.

.3 Dummy load for testing, adjustable to 150% of system rated output at 0.8 power factor lagging. Load on each phase adjustable from zero to 100% so that unbalanced output maybe tested for 3 phase systems.

.5 Tests:

.1 Visual inspection to determine that:

.1 Materials, workmanship, and assembly conform to design requirements.

.2 parts are new and free of defects.

.3 Battery and components are not damaged.

.4 Battery cells are of identical construction.

.5 Electrolyte in each cell is at manufacturer's recommended full level.

.6 Each battery cell polarity and polarity of connections to inverter is correct.

.7 Proper size fuses are installed.

.8 Meters have suitable range.

.9 Accessories are present.

.10 Portable meters for acceptance tests are suitable and instrument transformers connected correctly.

.2 Demonstrate:

.1 System start-up and shut down.

.2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times.

.3 Adjustable settings.

.4 Record values measured at test points using oscilloscope, digital multimeter, visicorder and camera attachment.

.5 That protective devices and indications function as designed. Record actual settings, and note operation of remote indications and transfer to bypass. Tests to include:

.1 Annunciator lights correct indication.

.2 Overcurrent on inverter output.

.3 Over-voltage and under-voltage of inverter output.

.4 DC input voltage to inverter too low. Gradually reduce DC input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.

.6 Simulate over temperature by applying heat to sensor with hot air blower.

.7 Simulate fuse blowing to test indication response.

.8 Simulate fan failure.

.9 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.

.10 Over-voltage of rectifier DC output.

.3 Harmonic test:

.1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion meter at output terminals.

.2 Determine each harmonic magnitude with harmonic wave analyzer.

.3 Measure phase to neutral at 0.8 lagging power factor.

.4 Transients:

.1 With normal power input, apply full load to system.

.2 Remove one half load from each phase.

.3 Reapply one half load instantly.

.4 Record voltages and currents using camera/oscilloscopes and/or visicorder.

.5 Steady load:

.1 Switch system onto AC mains, start inverter and connect dummy 0.8 power factor load.

.2 Operate system at full rated load for 24 h and at 125% load for 10 min in ambient temperature of 40°C.

.3 Record data at start of test and at half hour intervals thereafter; including:

.1 Input frequency.

.2 Input voltage each phase.

.3 Input current each phase.

.4 Input kW.

.5 Output voltage phase to phase, phase to neutral.

.6 Output current each phase.

.7 Output kW.

.8 Temperature of ventilating air-in.

.9 Temperature of ventilating air-out

.10 Temperature at critical zones.

.11 DC voltage to inverter.

.12 DC current to inverter.

.13 Rectifier DC current.

.6 Varying loads:

.1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.

.2 Calculate efficiencies of rectifier, inverter, and complete system.

.7 Unbalanced loads:

.1 Adjust loads on inverter to full load on two phases, 80% load on third phase.

.2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.

.3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.

.8 Battery:

.1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:

.1 Ambient temperature.

.2 Temperature of each cell.

.3 Voltage of each cell.

.4 Voltage of battery.

.5 Charging current.

.6 Specific gravity of each cell (lead acid battery only).

.2 Discharge battery by operating uninterruptible power system with AC mains open, at full rated output for duration quoted in design requirements. Record, at 5 min intervals.

.1 Voltage of battery.

.2 Current.

.3 Voltage of 10% random cells.

.4 Ambient temperature.

.5 Battery temperature.

.6 Specific gravity of 10% random cells (lead acid only).

.3 Recharge battery automatically by closing AC mains supply to system for 4 h period, with dummy load connected. Record at 15 min intervals.

.1 Battery voltage.

.2 Charging current.

.4 At start and finish of charge, record ambient and battery temperatures, and specific gravity of each cell (lead acid only).

.5 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 h charge period.

.6 Recharge battery.

.9 Operating sound level:

.1 Measure sound level according to ANSI S1.13 using sound level meter with A weighting and slow response, conforming to ANSI S1.4.

.2 Take reading by placing meter with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.

.3 Measure sound level during low ambient sound level.

1.8 Extended Warranty

.6 The Contractor hereby warrants the battery against defects in material and workmanship in accordance with GC: 13 and D25, but for 10 years. This warranty is for 100% replacement for the first year and prorated in equal yearly decreasing increments for the remaining 9 years until the expiration of the warranty at the end of 10 years from the date of Total Performance.

2. PRODUCTS

2.1 Uninterruptible Power System

.1 Input power:

.1 Three phase, 208V, 3 wire, grounded neutral, 60 Hz.

.2 Normal supply from AC mains.

.3 Emergency supply from standby automatic diesel-electric unit.

.2 Output power:

.1 Three phase, 208 V, 4 wire, grounded neutral, 60 Hz.

.2 Full load output at 0.8 power factor lagging 15 kVA.

.3 Overload capability: 125% of rated full load current at 0.8 power factor and rated voltage for 10 min.

.4 Frequency - nominal 60 Hz:

.1 Adjustable from 58.5 to 61.5 Hz.

.2 Maximum variation from set value under load changes, including transients, not to exceed 0.3 Hz.

.3 Drift from set value - after two months normal operation within ambient temperature range of 0° to 40°C, not to exceed 0.6 Hz.

.5 Duration of full load output after mains failure not less than 15 min.

.6 Output voltage control:

.1 Continuously adjustable on load at least 5% from rated value.

.2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

.3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.

.4 Harmonics over entire load range:

.1 Total rms value not to exceed 5% rms value of total output voltage.

.2 Single harmonic not to exceed 3% of total output voltage.

.5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.

.7 Efficiency: Overall system efficiency at rated load with battery fully charged not less than 75%.

.8 Interference suppression:

.1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.

.2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

2.2 System Performance

.1 Normal operation:

.1 System operates on mains power when mains voltage is within +/-10% of nominal value and mains frequency is between 59.5 and 60.5 Hz.

UNINTERRUPTIBLE POWER SYSTEMS STATIC

.2 Battery operation:

.1 System transfers automatically to battery operation.

.1 When manually selected at control panel.

.2 When mains power fails.

.3 When mains voltage varies more than 10% from nominal or mains frequency varies more than 0.5 Hz from 60 Hz.

.4 When mains power is restored and mains voltage is within 10% of nominal and mains frequency is within 0.3 Hz of 60 Hz, system automatically resynchronizes with mains.

.5 Slew rate of frequency during transition period of system output automatically synchronizing with mains and return to its internal frequency to be set between 0.5 to 1.0 Hz per second.

.3 Bypass operation:

.1 For maintenance purposes, system can be bypassed automatically by manual selection at control panel to connect load directly to AC mains. Transfer without load interruption and leaving inverter energized.

.2 Load transfer from mains back to system automatically by manual selection at control panel when maintenance completed.

.3 Automatic transfer of load to mains in not more than 1/4 cycle including sensing with inverter left energized but disconnected from load in case of:

.1 Inverter overloaded.

.2 Short circuit in load.

.4 Automatic retransfer of load to system without load interruption when above conditions disappear.

.5 Automatic transfer of load to mains in not more than 1/4 cycle including sensing and shutdown of inverter in case of inverter internal malfunctions.

.6 Automatic transfer of load to mains without load interruption and inverter shutdown in case of:

.1 Over-temperature harmful to system.

.2 Loss of forced ventilation.

.3 Low voltage of DC supply to inverter.

.7 Bypass capable of closing onto and withstanding momentary fault current of 800% of rating for 0.01 s.

2.3 System Protection

.1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during work on inverter.

.2 Automatic circuit breakers and protection included in:

.1 AC input to rectifier.

.2 Battery input.

.3 Bypass circuit input.

.4 Inverter output.

.3 Surge suppressors:

.1 To protect system against supply voltage switching transients.

.2 To protect internal circuits where necessary against voltage transients.

.4 Current limiting devices, with panel front indication of device operation, to protect inverter SCRs.

.5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.

.6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

2.4 Electrical Requirements

.1 Bring out test points to protected coded pin jacks at convenient locations to permit testing without hazard, including:

.1 Inverter output ahead of output switch, 3 phase and neutral.

.2 Mains power 3 phase and neutral.

.3 Voltage across each SCR.

.4 Points requiring monitoring for on-site alignment, for determination of faulty sub-assemblies or printed circuit cards, including indication of oscillator pulse and operation of voltage control.

.2 No battery, other than main battery incorporated in design.

.3 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.

.4 Variable resistors: fine adjustment, rheostat type.

.5 Phasing marked on input and output terminals, viewed from front of equipment:

.1 Left to right.

.2 Top to bottom.

.3 Front to back.

.6 Indicator lamps: long life incandescent or neon, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.

.7 Solid state circuits used where more reliable than mechanical timers or control relays.

.8 Standard components available from commercial sources used throughout, with 10 years minimum shelf life.

.9 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.

.10 Small components, related to specific function, removable plug-in modular sub-assembly or printed circuit card.

.11 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.

.12 Components and sub-assemblies accurately made for interchangeability.

2.5 Enclosure

.1 Dead front free standing sheet steel minimum 2.5 mm thick, CSA Enclosure 1A.

.2 Access preferably from front only, or from front and rear.

.3 Meters, indicating lamps and controls group mounted in panel front.

.4 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping. Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with 2 keys. Hinges to permit doors to be lifted off cubicle.

.5 Cubicle height not to exceed 1.8 m.

.6 External cable connections at top of cubicle through bolted plate for drilling at Site to suit.

.7 Ambient temperature range during operation - 20°C to +40°C. Natural or forced ventilation as required. For forced ventilation power from inverter output and fan directly driven by single phase motor mounted on vibration isolators. Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.

.8 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.

.9 Maximum operating sound level not to exceed 80 db(A) as measured on sound level meter with A weighting and slow response, at a distance of 1.o m.

.10 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

2.6 Rectifier

.1 Input power supply from:

.1 AC mains.

.2 Input disconnect: bolt-on molded case three pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.3 Isolating transformer: connected between AC input and rectifier input.

.4 Surge suppressor: to protect equipment from supply voltage switching transients.

.5 Rectifier:

.1 Silicon controlled rectifier assembly or sealed silicon diodes.

.6 Filter: for rectifier DC output.

.7 Fuse: to protect DC output.

.8 Meters:

.1 DC voltmeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output voltage.

.2 DC ammeter, switchboard type, accuracy +/-2% of full scale, to measure rectifier output current.

.9 Adjustments and controls:

.1 Line voltage adjusting taps to allow for +/-10% variation from nominal.

.2 Manual adjustment of float voltage with range of +/-5%.

.3 Manual adjustment of equalizing voltage.

.4 Automatic current limiting on rectifier adjustable between 80 and 120% of normal rating.

.5 Provision to disconnect rectifier from inverter and battery if rectifier DC output exceeds safe voltage limits of battery.

.10 Meters, adjustments and controls to be grouped on front panel.

.11 Performance of rectifier:

.1 Automatically maintain battery in fully charged state while mains power available, and maintain DC float voltage within +/-1% of setting, no load to full load, during mains voltage variations up to +/-10%.

.2 Battery charging rate such that after battery has provided full load power output for specified duration, charger returns battery to 95% of fully charged state in 4 h.

.3 Automatic equalize charging circuit to initiate equalize charging of battery for 24 h after discharge of 5% of ampere hour battery rating.

.4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 h to return unit to float charge.

2.7 Inverter

.1 Input power supply from:

.1 Rectifier DC output.

.2 Battery DC output.

.2 Input disconnect: bolt-on molded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.3 Input filter: with separately fused computer grade capacitor banks and indicator lights, to eliminate inverter source noise and restrictions on input cable length.

.4 Power stage: high frequency switching type, dual cooled disc type silicon controlled rectifier (SCR). Components, solid state devices capable of satisfactory operation under ambient conditions of -35°C to +55°C.

.5 Logic module:

.1 Integrated circuit logic.

.2 Silicon semiconductors.

.3 Plug-in modules.

.4 Gold plated plug-in connector.

.5 Front accessible field adjustments for voltage and frequency.

.6 Front accessible test points: suitably protected coded pin jacks.

.7 Frequency reference module.

.8 Current limiting module, automatic high speed by controlled reduction of output voltage.

.9 Voltage regulator.

.6 Output filter: output of high frequency switching stage contains elements of carrier frequency which are filtered to low harmonic sine wave.

.7 Meters:

.1 AC voltmeter: switchboard type, accuracy +/-2% of full scale, to measure inverter output voltage with 7 position selector switch to select phase to neutral, phase to phase, off.

.2 AC: switchboard type, accuracy +/-2% of full scale, to measure inverter output current with 4 position selector switch to select each phase and off.

.3 Wattmeter: switchboard type, accuracy +/-2% of full scale to measure inverter load.

.4 Frequency meter: switchboard type, scale 58 to 62 Hz, pointer type, to measure inverter output frequency.

.5 Synchroscope: with switch to check inverter output potential against supply mains potential.

.8 Output disconnect: bolt-on, molded case, three pole circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40°C ambient, magnetic instantaneous trip element.

.9 Meters and controls: grouped on front panel.

2.8 Battery

.1 Battery type and electrical characteristics:

.1 Discharge current to supply inverter at full load output, for 15 min.

.2 Sealed lead acid. 10 year life.

2.9 Static Bypass Switch

.1 Two solid state closed circuit automatic transfer switches.

.2 Logic unit with three normal source voltage sensors, which monitor over-voltage under-voltage and loss of voltage.

.3 High speed automatic transfer from normal voltage to alternate source when:

.1 Normal source voltage lost: transfer time and sensing 1/4 cycle.

.2 Normal source: under-voltage at 80% of nominal value adjustable.

.3 Normal source: over-voltage at 110% of nominal value.

.4 Loss of normal source static switch continuity.

.5 Short circuit on normal source trips normal source breaker.

.4 Return to normal source:

.1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.

.5 Switch position lights and contacts.

.6 Synchronizing verification light.

.7 Manual reset push-button.

.1 Transfer test switch.

.8 Alternate power source monitor light.

.9 Accessories:

.1 Manual bypass switch for maintenance and testing without load disturbance.

.2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.

.3 Alternate power source loss alarm contacts.

2.10 Operating Devices

.1 Operating Accessories:

.1 Counter for number of failures of normal mains AC power: non-reset type, zero to 99,999 operations.

.2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.

.3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.

.2 Mode lights mounted on front panel to indicate:

.1 AC output on inverter – green.

.2 AC input available – green.

.3 Inverter and AC input synchronized – green.

.4 Inverter and AC input not synchronized – amber.

.5 Static bypass switch in bypass position – red.

.6 Over-temperature alarms:

.1 Rectifier – red.

.2 Inverter – red.

.3 Bypass switch – red.

.7 Cooling fan fuse open – red.

.8 Inverter output over voltage – red.

.9 Inverter output under voltage – red.

.10 Battery over-voltage – red.

.11 Battery under-voltage – red.

.12 Inverter fuse/breaker open – red.

.13 Rectifier fuse/breaker open – red.

.14 Static bypass switch fuse/breaker open - red.

.15 UPS on battery operation – red.

.16 Rectifier in equalize mode – amber.

.17 Battery discharging indicator - red, to change from steady to flashing during final 5 to 10 min of battery duration.

.3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

.4 Remote status alarm system:

.1 2 status alarm annunciators for indication at 2 remote points, up to 10 m distant. Illuminated nameplates installed in cabinets for flush mounting in existing panels.

.2 Transmission cable supplied and installed by Contractor.

.3 Transmission distance 30 m.

.5 Communications

.1 Unit will communicate with the CDACS via Devicenet protocol and to the BMS system via RS232 port and unit software.

2.11 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements..

.2 Cubicles:

.1 Inside finish: white.

.2 Exterior finish: manufacturer’s standard colour.

.3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

2.12 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 For major components such as AC input breaker, inverter breakers, bypass switch: size 4 nameplates.

.3 For mode lights, alarms, meters: size 2 nameplates.

2.13 Fabrication

.1 Shop assemble:

.1 Rectifier unit.

.2 Inverter unit.

.3 Bypass switch unit.

.4 Battery rack and battery.

.2 Interconnect units, and add remote mode lights, alarms and controls to produce complete uninterruptible power system before requesting Contract Administrator to witness factory tests.

2.14 Approved Manufacturers

.1 The following are approved manufactures of this equipment

.1 Liebert - UPStation S3

.2 Powerware

.3 APC - DP330E

.4 Powerco

3. EXECUTION

3.1 Installation

.1 Locate UPS cubicles, battery rack and battery as indicated.

.2 Assemble and interconnect components to provide complete UPS as specified.

.3 Connect AC mains to main input terminal

.4 Connect UPS output to load.

.5 Start-up UPS and make preliminary tests to ensure satisfactory performance.

3.2 Testing

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and Section 01670 –Commissioning.

.2 Provide:

.1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.

.2 Dummy load adjustable to 150% of system rated output.

.3 Notify Contract Administrator 10 Business Days in advance of test date.

.4 Tests:

.1 Inspection of cubicles, battery rack and battery

.2 Inspection of electrical connections

.3 Inspection of installation of remote mode lights and alarms

.4 Demonstration of system start-up and shut-down

.5 Run UPS for minimum period of 4 h at full rated load to demonstrate proper operation with AC mains input, emergency generator input, no AC input

.6 Discharge battery by operating UPS with AC mains open for specified duration of full load. Record readings of temperature of each cell

.7 Recharge battery automatically with full rated load on UPS for 4 h and record readings of voltage of each cell.

3.3 Training

.1 Provide demonstration and training on equipment operation and maintenance in accordance with Section 01664 – Training and Section 16990 – Electrical Equipment and System Demonstration and Instruction

3.4 Extended Warranty

.1 The Contractor hereby warrants the battery against defects in material and workmanship in accordance with GC: 13 and D25, but for 10 years. This warranty is for 100% replacement for the first year and prorated in equal yearly decreasing increments for the remaining 9 years until the expiration of the warranty at the end of 10 years from the date of Total Performance.

END OF SECTION

MULTIPLEX FIRE ALARM SYSTEM

1. GENERAL

1.1 System Description

.1 Supply and install a complete raceway system and wiring to support an addressable multiplexed fire alarm system to be supplied under Division 13.

.2 All alarm initiating and signal devices shown on drawings are for reference only and will be supplied and installed under other Divisions.

2. PRODUCT

2.1 Materials

.1 CAN/ULC-S541.

2.2 General Requirements

2.3 Wiring

.1 Copper conductors.

.2 To initiating circuits: 18 AWG FAS minimum, and in accordance with manufacturer's requirements.

.3 To signal circuits: 14 AWG FAS minimum, and in accordance with manufacturer's requirements.

.4 To control circuits including strobes: 14 AWG FAS minimum, and in accordance with manufacturer's requirements.

.5 Risers: twisted, shielded pairs #22 AWG FAS, 1 h fire-rated configured to eliminate interference.

2.4 Raceway

.1 Rigid Aluminum conduit as per Fire Alarm Riser Diagram.

3. EXECUTION

3.1 Installation

.1 Splices are not permitted.

.2 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and central control unit, as required by equipment manufacturer.

.3 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.

.4 Identify circuits and other related wiring at central control unit, annunciators, and terminal boxes.

.5 Leave sufficient spare cable at the field device locations and at the transponder locations to allow termination of the cable in the devices and transponders provided and installed by Contract 2S.

3.2 Field Quality Control

.1 Perform Tests in accordance with Section16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and CAN/ULC-S537.

END OF SECTION

TELECOMMUNICATIONS RACEWAY SYSTEM

1. GENERAL

1.1 System Description

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, terminal cabinets, conduits, cabletroughs, pull boxes, sleeves and caps, fish wires, service poles, service fittings and concrete encased ducts.

.2 Overhead cabletrough distribution system.

2. PRODUCTS

2.1 Material

.1 Conduits, Conduit Fastenings and Conduit Fittings: Section 16111

.2 Cabletrays:Section 16114

.3 Wireways and Auxiliary Gutters: Section 16116

.4 Splitters, Junction Boxes, Pull Boxes and Cabinets: Section 16131

3. EXECUTION

3.1 Installation

.1 Install empty raceway system, including overhead distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable trays; raceways, service poles, miscellaneous and positioning material to constitute complete system.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 References

.1 NEMA Contactors and motor-starters.

1.2 Starter Requirements

.1 In general, there are categories of starting equipment for three phase motors.

.1 Integral Mounted Starters: Some items of mechanical equipment such as boilers have the starter mounted as part of the equipment. For this equipment, install disconnects and wire to the terminals of the equipment.

.2 Separately Mounted Starters: For motors without integral mounted starters, supply and install separately mounted starters as required and wire the equipment.

.3 Starters in Motor Control Centres: For motors fed from motor control centres, wire from the equipment to the motor control centres.

.2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 For all starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc., whether integrally or remote mounted, use heavy duty oil tight, unless otherwise specified.

1.3 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 01300 – Submittal Procedures.

.2 Indicate:

.1 Mounting method and dimensions
.2 Starter size and type
.3 Layout of identified internal and front panel components
.4 Enclosure types
.5 Wiring diagram for each type of starter
.6 Interconnection diagrams.

1.4 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01730 – Operations and Maintenance Manuals.

.2 Include operation and maintenance data for each type and style of starter.

1.5 Maintenance Materials

.1 Provide listed spare parts for each different size and type of starter:

.1 3 contacts, stationary.

.2 3 contacts, movable.

.3 1 contact, auxiliary.

.4 1 control transformer.

.5 1 operating coil.

.6 2 fuses.

.7 10% indicating lamp bulbs used unless LED indicators.

2. PRODUCTS

2.1 Materials

.1 Starters: to NEMA Standards.

2.2 Enclosure

.1 Enclose all individually mounted motor starters in a general purpose sheet steel enclosure unless in process areas where the enclosure shall be watertight EEMAC 4 or 4X.

2.3 For all motors 22.4 kW and above, furnish starters accessories as detailed on the drawings.

2.4 Manual Motor Starters

.1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break
.2 Overload heaters, manual reset, trip indicating handle,
.3 Rated volts and poles to suit application.

.2 Accessories:

.1 Push-button: oil-tight labelled as indicated.

.2 Indicating lights: oil tight type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.5 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated, rapid action type
.2 Motor overload protective device in each phase, manually reset from outside enclosure.
.3 Wiring and schematic diagram inside starter enclosure in visible location
.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:

.1 Locking in "OFF" position with up to 3 padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Pushbuttons and selector switches: oil tight labelled as indicated.

.2 Indicating lights: oil tight type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.

.3 In addition to standard, 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

.4 For all starters and components, provide interconnection wiring to Plant SCADA ystem. Monitored status includes the following:

.1 COA control switch position

.2 Motor running status

2.6 Full Voltage Reversing (FVR) Magnetic Starters

.1 Full voltage reversing magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Two - 3 pole magnetic contactors mounted on common base
.2 Mechanical and electrical interlocks to prevent both contactors from operating at same time
.3 Three smart overload relays with adjustable settings, manual reset.

.2 Accessories:

.1 Pushbuttons and selector switches: oil-tight labelled as indicated
.2 Indicating lights: oil-tight type and color as indicated
.3 Auxiliary control devices as indicated.

.4 DeviceNet Module for transmitting starter information and receiving setting adjustments to/from a central control facility

2.7 Multi-Speed Starters

.1 Not Used

2.8 Three Phase Manual Reversing Starter

.1 Not Used

2.9 Control Transformer

.1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120V secondary, complete with primary and secondary fuses (HRC Form J), installed in with each starter.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.10 Finishes

.1 Apply finishes to enclosure in accordance with Section 16010 - Electrical General Requirements.

2.11 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Manual starter designation label engraved as indicated.

.3 Magnetic starter designation label, engraved as indicated.

3. EXECUTION

3.1 Installation

.1 Install starters; connect power and controls as indicated.

.2 Ensure correct fuses and overload devices elements are installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to Performance Verification equipment. As a minimum, verify the following:

.1 Check of control circuits
.2 Verify that overload relay installed is correctly sized for motor used
.3 Record overload relay setting and motor nameplate amperage
.4 Visual inspection of fuses and contactors
.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select overload relay settings in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relay settings to suit the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions and Section 01670 – Commissioning.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.5 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 -Training and Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

LOW VOLTAGE SOFT STARTERS 600 V

1. GENERAL

1.1 Scope of Work

.1 This specification describes the requirements for the supply, factory testing and installation of low voltage soft starters for 3-phase, squirrel cage induction motors as required by various process and mechanical equipment required for this Work.

.2 Soft starters and their associated over-current protection devices shall be connected as detailed on the drawings.

1.2 References

.1 Use medium voltage starters manufactured and tested to conform to the following industry standards and specifications:

.1	ANSI	American National Standards Institute
.2	CSA	Canadian Standards Association
.3	IEEE	Institute of Electrical & Electronic Engineers
.4	UL	Underwriters Laboratories
.5	EEMAC	Electrical & Electronic Manufacturers Association of Canada
.6	NEMA	National Electric Manufacturers Association

1.3 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Mounting method and dimensions
.2 Starter size and type
.3 Layout of identified internal and front panel components
.4 Enclosure types
.5 Wiring diagram for each type of starter
.6 Interconnection diagrams.

1.4 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor starters for incorporation into manual specified in Section 01730 – Operation and Maintenance Manuals.

.2 Include operation and maintenance data for each type and style of starter.

1.5 Maintenance Materials

.1 Provide listed spare parts for each different size and type of starter:

.1 3 contacts, stationary.

.2 3 contacts, movable.

.3 1 contacts, auxiliary.

.4 1 control transformer.

.5 1 operating coil.

.6 2 fuses.

.7 10% indicating lamp bulbs used.

2. PRODUCTS

2.1 Soft Starter

.1 The system consists of a single enclosure containing soft starter, by-pass contactor, protection relay, and UPS (PORT option only).

.2 Supply each starter with a fully rated NEMA bypass contactor, which is utilized to provide bypass of the SCR power poles once the motor is up to full speed. When a stop is commanded, the bypass contactor opens while the SCR poles are operating so that it does not have to open under full voltage.

.3 Provide a door mounted soft starter by-pass switch to allow across the line starting. Provide terminal blocks for by-pass switch position status.

.4 Provide the starter containing a six (6) SCR power section with two (2) SCRs per phase connected inverse parallel for variable AC output voltage with minimal motor and starter heating. Design the power section to be capable of providing maximum torque per amp throughout the motor's speed-torque curve.

.5 Furnish the logic control to perform all of the necessary starter functions.

.6 In the logic control, incorporate a microcomputer, which consists of all of the circuitry required to drive the power semiconductors that are located in the power section. Configure the logic to provide the following standard features:

- Electronic motor overload,
- Adjustable up-to-speed motor protection (off; 0 to 300 seconds)
- Adjustable over/under voltage protection
- Adjustable line to average current imbalance
- Adjustable high and low frequency protection
- Single phase protection
- Adjustable starts per hour (off or 1 to 20 starts)
- Adjustable time between starts (off or 1 to 600 minutes)
- Backspin timer (off or 1 to 200 minutes)

LOW VOLTAGE SOFT STARTERS 600 V

- Programmable over current detection level (off or 50 to 800%) and delay time (0.1 to 90.0 seconds)
- Programmable undercurrent detection level (off or 10 to 100% and delay time (0.1 to 90.0 seconds)
- Programmable residual ground fault detection level (off or 1 to 100 amps) and delay time (0.1 to 90.0 seconds)
- All faults can each be set to either trip the starter or activate a relay
- Instantaneous electronic over-current trip
- Shorted SCR detection
- Phase rotation selectable ABC, CBA, or Ins (insensitive)
- Emergency restart capability
- Two programmable ramp profiles selectable at any time via a 120 volt input
- Initial current, maximum current, and ramp time adjustments for each ramp
- Tru-torque ramp profile (kW ramp profile)
- Kick current and time adjustments for each ramp
- Adjustable deceleration profile
- Local start/stop controls
- Adjustable Ramp Time (0-120 seconds)
- Adjustable Initial Current (50%-400%)
- Adjustable Max Current (100%-600%)
- Motor Deceleration and S-Curve Deceleration Control (0-60sec.)
- Line Phase Loss Detection
- Line Current Imbalance Detection (10-40%)
- Over/Under Line Voltage Protection (10% - 30%)
- Up to speed indication
- Plain English operation via back lit LCD display interface
- LCD and LED status and diagnostics (full fault annunciation)
- Programmable automatic fault reset capability
- Programmable metering
- Programmable relay outputs
- Latched fault relay output
- External trip input
- Zero-speed switch input
- Real time clock
- Time stamped event recorder (99 events)
- Password protection
- Battery backed-up starter parameters and lockout times

.7 Provide each motor starter with the capability to display the following information.

- Each phase current.
- Average current.
- Phase 1 current.
- Phase 2 current.
- Phase 3 current.
- Each phase voltage.

- Average voltage.
- Phase 1 voltage.
- Phase 2 voltage.
- Phase 3 voltage.
- Frequency.
- Thermal overload in percentage from 0% to 100% (100% = Trip).
- Motor power factor.
- The elapsed running time in tenths of an hour (non-resettable).
- The elapsed running time in hours (non-resettable).
- The user re-settable elapsed running time.
- The user re-settable motor starts counter.
- Motor real power consumption.
- Kilo-watt-hours used by the motor.
- Mega-watt-hours used by the motor.
- Motor reactive power consumption.
- Motor apparent power consumption.
- Ground fault current in amps.
- Motor starts counter.
- Motor current imbalance in percentage.

.8 Furnish the starter with the ability to provide switching control for power factor capacitors. Configure so that the capacitors are disconnected when the starter is stopped, accelerating or decelerating and the capacitors are connected when motor is running full speed, and the bypass contactor is closed.

.9 Provide inputs for RTDs or thermisters as indicated in the Drawings.

.10 Provide the starter with Modbus Ethernet communications capability

2.2 Power Outage Ride Through (PORT)

.1 Provide each motor starter with Power Outage Ride Through (PORT) functionality.

.2 Provide and configure the control logic to provide the following parameters:

- Fault Delay
- Sense Time
- Bypass Delay
- Forward #2 Ramp Profile

.3 Provide each motor starter with a properly sized UPS unit to supply control power to each motor starter for the PORT function. UPS alarm output signal shall be wired to terminals or connected to the motor protection relay.

2.3 Motor Protection Relay

.1 For motors 150 hp and above provide a GE Multilin M60 motor protection relay.

.2 Modbus TCP/IP communications to the plant SCADA system utilizing a 10BaseF connection.

.3 Embedded IEC 61850 protocol and single channel fiber optic inter-relay communications.

.4 19 inch rack mount.

.5 Provide the following I/O cards:

.1 Four (4) form-C outputs, eight (8) digital inputs.

.2 Eight (8) RTD inputs.

.3 Four (4) 4-20mA inputs, four (4) 4-20mA outputs.

2.4 Enclosure

.1 Provide each motor starter with NEMA [1], [4], [12], [12V (ventilated with filter elements)] enclosure.

2.5 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

2.6 Acceptable Manufacturers

.1 Benshaw RediStart Micro II

3. EXECUTION

3.1 Installation

.1 Install starters, connect power and control as required.

.2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to testing equipment. As a minimum, verify the following:

.1 Check of control circuits
.2 Verify that overload relay installed is correctly sized for motor used
.3 Record overload relay size and motor nameplate amperage
.4 Visual inspection of fuses and contactors
.5 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Motor Protection

.1 Overload time/current settings will be determined by a coordination study provided by the City. The Contractor shall program all the parameters as determined by the Coordination Study.

.2 Provide a list of protection parameters, curves and data sheets and software for the protection relays settings.

.3 For starters provided, select and configure all motor protection parameters in accordance with motor manufacturers' recommendations, considering motor service factors, ambient temperature, and temperature differences between motor and starter locations. Monitor motor operation during startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suit the start-up condition. Provide manufacturers' curves and data sheets to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Operate switches, contactors to verify correct functioning.

.2 Perform starting and stopping sequences of contactors and relays.

.3 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

3.5 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 -Training and Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Standards

.1 All variable frequency drives (VFDs) shall meet or exceed the following specifications.

.2 Provide a complete inventory (as specified) of spare cooling fans, and fuses, for each VFD supplied.

.3 Design the adjustable frequency controller to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting NEMA MG1 Part 31.

.4 Harmonic loading will not exceed a motor service factor of 1.0.

.5 Use products complying with IEEE Standard 519.

.6 Use VFD units that UL listed and CSA certified.

.7 VFD unit to comply with applicable requirements of the latest standards of CSA, ANSI, IEEE and the Canadian Electrical Code.

1.2 Tests

.1 Factory testing

.1 Factory test VFD units prior to shipment. Provide confirmation from factory of actual tests completed and results.

.2 Provide certified copies of production test results required by CSA and EEMAC, prior to acceptance of the equipment.

.2 Field testing

.1 Employ the VFD Manufacturer's Rep to provide on Site startup, fine-tuning, Performance Verification, operator training and instruction.

.2 Employ the VFD Manufacturer's Rep to provide Site functionality test reports indicating loading / current levels during testing as well as control point proving results.

.3 Have the VFD Manufacturer's Rep ensure shaft to ground voltages do not exceed 1.5 volts at any speed or load requirement.

.4 Allow for all costs and labour for as many trips as necessary to complete requirements.

.5 Provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:

.1 Single line drawing

.2 Additional information on electrical system layout and load profile

The VFD Manufacturer's Rep can use this information to evaluate the predicted effect of the VFD installation on the electrical system and design input line reactors to mitigate these adverse effects. For the purposes of analysis, the point of common coupling (PCC) will be taken as the secondaries of the main 600V distribution transformers.

.6 In conjunction with the Supplier, conduct a harmonic analysis upon completion of fine tuning and prior to Substantial Performance. Conduct the harmonic analysis at 50%, 75%, and 100% speed under normal load conditions. Perform a fourier (FFT) transform analysis spectrum for each waveform covering the fundamental to the 31st harmonic. Should the waveform analysis indicate that either the input or output voltage and current levels of the VFD(s) exceed NEMA Standards for electric motors and IEEE 519, the VFD supplier to provide, at their cost, all the necessary line filtering equipment to correct the harmonic distortion.

.3 Provide certified copies of all production test results required by CSA and NEMA.

1.3 Shop Drawings

.1 Provide Shop Drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Rating: voltage, amperage, maximum horsepower

.2 Mounting methods and dimensions

.3 Wiring diagram

.4 Layout and identification of front panel components

.5 Enclosure type

.6 Interconnection diagrams

.3 The shop drawings for each type/size of V.F.D. must be specific to that unit. A generic shop drawing is not acceptable. The shop drawings are to include dimensions and physical details of the cabinets, a wiring diagram and a ladder diagram showing both internal connections and terminals for field wiring. Separate diagrams are required for each VFD/motor functions. Generic diagrams are not acceptable.

1.4 Operation and Maintenance Data

.1 Provide Operation and Maintenance data for each size and type of VFD for incorporation into the Maintenance manual as specified in Section 01730 – Operations and Maintenance Manuals.

.2 Include:

.1 Copy of the approved Shop Drawings

.2 Parameter settings and test reports

2. PRODUCTS

2.1 Variable Frequency Drives

.1 Variable Frequency Drives as supplied by one of the following acceptable manufacturers:

.1 ABB

.2 For variable speed controller, use electronic adjustable frequency and voltage output unit.

.3 Use VFD employing a minimum 6-pulse PWM (pulse width modulated) inverter system utilizing Insulated Gate Bipolar Transistors (IGBT) power switching devices and come complete with line reactors or DC link filters.

.4 Provide drive rated for continuous duty while operating a NEMA design induction motor of the sizes and operating voltages as shown in the following schedules and indicated on the drawings. Size drive output for a 1.0 motor service factor. Ensure the VFD has a current rating at least 10% in excess of the motor full load amp rating. Provide overload service factors of 110% for thirty minutes and 135% for one minute, to ensure adequate safety margins. Base VFD selection on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.

.5 Use a VFD that has a fixed bridge type converter (PWM) with a minimum of 98% input displacement power factor over a 10 to 100% speed range. Ensure the efficiency is a minimum of 97% for all inverters when operated at full speed and load.

.6 Input voltage - as indicated on motor schedules and drawings (line voltage variation ±10%), based on 347/600 volt systems (Not 575v). Line frequency variation ±5%. Design so that output voltage varies with motor speed to nominal motor voltage. Speed stability - ±1%. Select and design drive to match torque characteristic of load.

.7 Input frequency setting signal - selective between 4 to 20 mA or 0-10v DC. Output speed monitoring signal - selective between 4 to 20 mA or 0-10v DC.

VARIABLE FREQUENCY DRIVES

.8 Open copper buswork to be tin plated.

.9 Enclosure:

.1 Install drive in motor control centres or with individual CSA 1 enclosure, drip proof or Nema 12 as indicated on drawings. Provide filters for any forced air cooled enclosures as required by the manufacturer. Use VFD(s) suitable for mounting in a typical building electrical room able to operate under these conditions with no special cleaning requirements. Mount VFD cabinets in such a way that there is adequate room for ventilation and no build up of heat. Ensure the minimum clearance in front of VFD's is 1m.

.10 Protective devices to be incorporated are:

.1 Fast acting electronic circuit board protective devices for protection of electronic components.

.2 Line reactor, DC link or filter in the drive input to protect electronic components from transient voltage conditions.

.3 Integral electronic motor overload protection adjustable up to 150% of motor rating for 60 seconds.

.4 Overcurrent instantaneous trip 250%.

.5 Programmable short-circuit protection.

.6 Programmable ground fault protection.

.7 Overvoltage / overcurrent DC bus monitor/protection.

.8 Undervoltage protection.

.9 Loss of phase and phase unbalance protection.

.10 Inverter over-temperature protection.

.11 Capable of running without motor for startup.

.12 Output filter package (as required) to limit motor voltage to 1200 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.

.13 Longlead (motor feeder) filter package, as required for these installations. Contractor is responsible to determine where this will be required, at the pre-construction meeting. All motors further than 45m from the VFD to be considered longlead.

.14 Maximum acceptable noise level is 80dBA at 1m.

VARIABLE FREQUENCY DRIVES

.11 Operational features:

.1 Provide integral flush mounted display in VFD cover with keypad for programming, monitoring and operating of drive, accessible through password or other acceptable security measure only. Also provide remote keypads, completely duplicating functions of integral keypads, for all VFD(s). In these cases, locate the remote keypads adjacent to the motor.

.2 Fault shutdown and indication.

.3 Automatic restart following power outage.

.4 Ability to disconnect motor load for setup or trouble.

.5 Manual speed control (potentiometer or keypad).

.6 Adjustable maximum and minimum speed.

.7 Acceleration and deceleration time adjustment.

.8 Controller "stop" interlock from a NC dry contact.

.9 Drive fault contact.

.10 Stop/start push buttons on key pad.

.11 Transient voltage protection.

.12 Provide three (3) dry "C" type contacts programmable for any combination of the following:

.1 Running (output frequency being generated)

.2 Fault lockout

.3 Stopped

.4 At speed

.5 Under speed

.6 Forward/Reverse

.7 Low reference

.8 Manual/Auto Mode

.9 Local/Remote Mode

.13 Soft start sequence.

.14 Regenerative braking.

.15 Minimum of three (3) skip frequencies.

.16 Provide Hand/Off/Auto selector switch. Keypad H/O/A is not an acceptable replacement.

.17 Password protection of parameter programming or some method to prevent unauthorized changes.

.18 Output speed monitoring signal to be selective between 4-20 mA. or 0-10 volt.

.19 Devicebus data communication link.

.1 Provide data communication links with various components in the electrical distribution system as specified in various Sections of this Division and as shown on drawings. The data communication link shall be Devicenet ODVA, Ethernet/IP or Modbus TCP/IP.

.1 Motor control data communication link.

.2 Provide each motor control component (motor starter, variable frequency drive) with Devicebus data communication link capable of communicating with the plant-wide Computerized Data Acquisition and Control System (CDACS).

.2 Refer to the following Sections for the functionality of the motor controller communication link:

.1 Section 16811 - Motor Starters to 600V

.3 The data communication link selected and used to communicate with the motor controller described above must be identical.

.12 Environmental Capabilities: Select and design the drive to operate without mechanical or electrical damage under any combination of conditions as follows:

.1 Ambient temperature -0° to 40°C.

.2 Humidity 0 to 90% (non condensing).

.3 Vibration up to 0.5 g.

.4 Altitude to 1250m.

.5 Slight (trace) sulphur environment (H_2S) present (less than 1 ppm).

.13 Diagnostic and indicating features:

.1 Power On indication.

.2 Percentage speed indicator.

.3 Overload indication.

.4 Short circuit indication.

.5 Ground fault indication.

.6 Overvoltage indication.

.7 Undervoltage indication.

.8 High temperature (controller).

.9 AC voltmeter (output).

.10 AC ammeter (output).

.11 Inverter ready.

.12 Inverter fault.

.13 External fault.

.14 Cooling System:

.1 Provide adequate proven cooling devices for VFD equipment.

.2 Ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans or sufficient guarded filtered openings, or both.

.15 Normal Distribution

.1 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:

.1 Line transients of up to 3,000 volts with energy levels of 50 joules.

.2 Line surges of up to 115% of rated voltage for up to 10 cycles. Based on 347/600 Volt systems.

.3 Line voltage sags down to 85% of rated voltage of up to 1 second duration.

.2 Control wiring - TEW 105° C rise.

.3 Terminal blocks in separate control enclosures for remote interface - Weidmueller SAK6N.

.4 Provide wire markers at both ends of all control wires, Electrovert Type Z.

3. EXECUTION

3.1 Operations Manual Information

.1 Orovide the Variable Frequency Drive (VFD) manufacturer an as built of each motor application. Motor application data will include at a minimum, the following:

.1 Motor manufacturer

.2 Class

.3 Motor model number

.4 Motor serial number

.5 Motor frame

.6 Motor horsepower (hp)

.7 Motor full load amps

.8 Motor conductor size

.9 Ground conductor

.10 Length of conductors from VFD to Motor

.11 Motor MCP or fuse and overload

.2 Installation

.1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor mounted equipment.

.2 Install VFD(s) in locations as indicated on drawings, and connect all necessary wiring. Mount all VFD(s) as close to the motor as possible. Follow manufacturer's recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFD's is 1m. See drawings attached. Where required, install longlead motor package.

.3 Extend analog input signal cable, analog speed indicating output cable, shutdown contact and drive fault contact from the drive to the Building Management System (BMS). Analog cable - No. 16 shielded twisted pair cable. Run control wiring in conduit separate from VFD supply and motor feeder conduits.

.4 Connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) or Auto (remote) configurations.

.5 Ensure that all control and stop commands shut down the drive as per manufacture's recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.

.6 Label MCC disconnect switch, VFD and motor isolation switch with proper shutdown procedures as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

.7 Run motor supply cables / conductors in conduits separate from supply feeders to line side of VFD. Do not tape or bundle conductors (supply or motor feeders) within the conduits.

.3 Field Quality Control

.1 Be responsible for complete Performance Verification of each variable speed drive to satisfaction of the Contract Administrator. Allow for factory representative to completely calibrate all drive circuits after installation on Site.

.2 Be responsible to bring factory representative back to reset, repair, and verify proper operation of the VFD during the two year warranty period, if problems arise with the normal operation of the VFD. This work includes prevention of any motor shaft voltages exceeding 1.5 volts when referenced to ground.

.4 Variable Frequency Drive Check-list

.1 Upon receiving the Notice to Proceed, furnish a VFD check-list that is to be completed and submitted with the VFD Shop Drawings. An example of the VFD check-list is attached to these specifications.

.5 Software

.1 Provide VFD programming / troubleshooting software to the City.

.2 Provide VFD Parameter list "as programmed during Performance Verification" for each VFD.

.6 Equipment Identification.

.1 Provide labels / lamacoids on each VFD, MCC disconnect, isolation switch in accordance with Section 16010 – Electrical General Requirements.

.2 In addition provide signage as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

3.2 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 -Training and Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

3.3 Extended Warranty

.1 The Manufacturer to provide warranty coverage for a period of two (2) years upon Total Performance when the warranty period has commenced.

.2 Review specifications of motors for application compatibility. Obtain and submit written approval from both the motor and VFD suppliers confirming that both pieces of equipment are compatible when used together to maintain the required warranty.

.3 Indicate the level of local support detailing response time if a piece of equipment should fail or malfunction. Include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number.

.4 The manufacturer to certify that they are prepared to support the equipment for a period of at least 10 years from date of final acceptance

END OF SECTION

MOTOR CONTROL CENTRE

1. GENERAL

1.1 References

.1 CAN/CSA-Q9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 – Submittals.

.2 Indicate:

.1 Outline dimensions
.2 Configuration of identified compartments
.3 Floor anchoring method and dimensioned foundation template
.4 Cable entry and exit locations
.5 Dimensioned position and size of busbars and details of provision for future extension
.6 Schematic and wiring diagrams.

1.3 Operation and Maintenance Data

.1 Provide operation and maintenance data for motor control centre for incorporation into manual specified in 01730 Operation and Maintenance Manuals.

.2 Include data for each type and style of starter.

.3 Provide all software necessary to program and operate the internal components

1.4 Source Quality Control

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Contract Administrator to witness standard factory testing of complete motor control centre including operation of switches, circuit breakers, starters and controls.

.3 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

2. PRODUCTS

2.1 Supply Characteristics

.1 600 V, 60 Hz, wye connected, 3 phase, 3 wire, grounded.

MOTOR CONTROL CENTRE

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars.

.2 Metal enclosed, free standing, enclosed dead front.

.3 TVSS unit as described in Section 16480 to be installed in each MCC.

.4 Indoor EEMAC type 1A gasketed enclosure, front or back to back mounting as indicated on drawing.

.5 Class II Type B.

.6 Approved Manufacturers:

.1 Schneider Electric.

.2 Allen-Bradley.

.3 Eaton Cutler Hammer.

.7 Where indicated locate all VFD type starters in a common part of the MCC and isolated from the main section of the MCC with a split buss arrangement to allow insertion of a Universal Harmonic filter ahead of the VFD starters.

2.3 Vertical Section Construction

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 165 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of motor control centre, isolated from busbars by steel barriers.

.5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at top or bottom as indicated.

.8 Provision for outgoing cables to exit via top or bottom.

.9 Removable lifting means.

.10 Provision for future extension of both ends of motor control centre including busbars without need for further drilling, cutting or preparation in field.

.11 Divide assembly for shipment to Site, complete with hardware and instructions for re-assembly.

2.4 Sills

.1 Continuous 75 mm x 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of motor control centre, supported on insulators and rated:

.1 Main horizontal busbars: as indicated.
.2 Branch vertical busbars: 300 A.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 65 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage, surface designed to discourage collection of dust.

2.6 Ground Bus

.1 Copper ground bus extending entire width of motor control centre.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters and Devices

.1 Equip the MCC with the combination starters as specified in Section 16811 - Motor Starters to 600 V, and as shown on the drawings.

.2 Control circuits for all starters are specified in Div 17. All starters are to be controlled and monitored by the SCADA control system.

.3 Provide PC Windows based communications software for setting and monitoring all starter devices where necessary.

2.8 Starter Unit Compartments

.1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure. Terminal block accessible for electrical testing of starter.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one to four padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Smart electronic overload relays manually or remotely reset from front with door closed.

.6 Pushbuttons, selector switches and indicating lights mounted on door front.

.7 Devices and components supplied by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 Wiring Identification

.1 Provide wiring identification in accordance with Section 16010 - Electrical General Requirements.

2.10 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.1 Motor control centre main nameplate: engraved as indicated.

.2 Individual compartment nameplates: engraved as indicated.

2.11 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.

.2 Paint motor control centre exterior light gray and interiors white.

3. EXECUTION

3.1 Installation

.1 Set and secure motor control centre in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload elements are set.

.4 Some re-arrangement of compartments is permitted from that indicated to suit manufacturer's standards, provided that re-arrangement gives approximately the spaces shown on the drawings. Submit arrangement drawings to the Contract Administrator before starting detailed drawings.

.5 Coordinate, with Division 03, concrete pad with bevelled edges as shown on the drawings, sized to suit MCC, install and level channel sills and mount MCC.

.6 Provide control centres with vertical sections, each 2286 mm high, 508 m deep and 508 mm wide, assembled into a group having a common power bus and forming an enclosure to which additional sections may be readily added.

.7 Provide main circuit carrying parts cable of withstanding, without damage, a line to line or line to ground shot circuit corresponding to a symmetrical RMS current of 65 KA amperes, unless otherwise indicated. Brace main busses to withstand a similar short circuit.

.8 Design for all power and control connections to be made from the front. Make all bus and feeder bolted connections accessible from the front.

.9 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tie supports. Insulate wireways from horizontal and vertical bus.

.10 Incorporate starters, circuit breakers, panels, etc. as detailed. Provide shop drawings for review before commencing fabrication.

.11 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all bus work.

.12 For each section of structure, provide a 3 phase horizontal bus rated as shown, and a 3 phase vertical bus rated 300 amperes. Tin plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section. Where indicated on MCC schedule, provide fully rated neutral. Bus - copper with labyrinth design insulation - isolation for vertical bus.

.13 Contain each complete control device within an individual metal enclosure completely isolated from all other equipment. Provide plug-in type units.

.14 Provide tin plated copper bus bar stabs reinforced with strong spring steel to ensure high contact pressure..

.15 Equip door of each individual unit with a removable plate replaceable with similar plate complete with pushbuttons, pilot lights or selector switches as required. Use pilot lights of push-to-test type and push button of heavy duty oil tight construction.

.16 Provide appropriate flanges and bus connections for incoming line and feeders.

.17 All joints and connections to be tin plated, galvanize all bolts, nuts and lock washers to resist corrosion.

.18 Provide pull apart terminal block plug in each starter for all external control connections, such that each starter unit may be easily removed. Identify all terminals.

.19 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or spaces are provided. Also use barriers to provide phase to phase isolation of the vertical bus.

.20 Affix complete control wiring diagrams for each starter with conductor identification clearly shown to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC.

.21 Extend control wiring from each starter module to the Instrumentation Marshalling Panel in the same room. Install a multi unit style terminal block having screw type terminal connections on standoff supports on back plate.

.22 Number code all terminals, or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.

3.2 Starter Verification

.1 Field check motor starters supplied prior to testing associated equipment. As a minimum, verify the following:

.1 Check of control circuits
.2 Direction of motor rotation
.3 Verify that overload relay installed in correctly sized for motor used
.4 Record overload relay size and motor nameplate amperage
.5 Visual inspection of fuses and contactors

.6 Ensure all connections are tight.

.2 Measure and record motor amps, under load conditions and compare with full load amps and motor service factor. Report any excessive readings and unbalance. Measure voltage as close to motor terminals as possible while motor is running.

.3 Set all motor circuit protectors to the minimum level which will consistently allow the motor to start under normal starting conditions.

3.3 Overload Relays

.1 For starters provided, select electronic smart overload relays with Device Net communications interface in accordance with relay and motor manufacturers' recommendations, considering motor service factors, ambient temperature, temperature differences between motor and starter locations. Monitor motor operation during start-up to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time motors, provide special overload relays to suit the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of motor control centre during 8 h period.

3.5 Training

.1 Provide Demonstration and Training on Equipment Operation and Maintenance in accordance with Section 01664 -Training and Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Work Included

.1 Control equipment such as (a) pushbutton stations, indicating lights, control and relay panels, are provided under this specification to form complete control system for a process unit in conjunction with (b) such items as motor control centre, starters, and (c) items provided under Division 17 for example, pressure, flow, float, solenoid valves, panels, pneumatic electric switches, transducers.

.2 A process unit is a Vendor Package or individual process equipment as specified in other Sections. Some or all of preceding items are interconnected under Part 3 of this specification. Specify control components and assemblies relative to the work. Ensure work required to be performed is indicated on the Supplier's layout drawings, diagrams and motor starter and control list.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 01300 - Submittals.

.2 Indicate:

.1 Outline dimensions
.2 Configuration of identified compartment
.3 Schematic and wiring diagrams.

1.3 Operation and Maintenance Data

.1 Provide operation and maintenance data for control devices for incorporation into manual specified in Section 01730 – Operations and Maintenance manuals.

.2 Include data for each type and style of device.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from NO to NC, electrically held with sliding barrier to permit access to contacts only or coil only, 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

.2 Sealed contact type: electrically held with 3-4 poles and front mounted contact block. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

.3 Universal pole type: electrically held with 3-4 poles, convertible from NO to NC by changing wiring connections. Coil rating:120 V. Contact rating: 120 V, min 3 A.

.4 Fixed contact type: heavy duty with 3-4 poles. Coil rating: 120 V. Contact rating: 120 V, min 3 A.

2.2 Relay Accessories

.1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

2.3 Sealed Contact Oiltight Limit Switches

.1 Lever type switches: roller operated, double pole, double throw. Contact rating: EEMAC B-600.

.2 Push type switches: actuated by rod located on tip or side of operating head, spring return double pole, double throw. Contact rating: EEMAC B-600.

.3 Wobble stick cat whisker type switches: actuated by rod or stick extending from tip of operating head. Moving rod in any direction operates contacts. Double pole, double throw. Contact rating: EEMAC B-600.

.4 Lever operated: time delay switch: adjustable time delay from 1/2 s to 15 s plus 25%. Contact rating: EEMAC B-600.

.5 Plug-in construction switches: CSA Type 4, lever or push type, contact rating: EEMAC A-600.

2.4 Solid State Timing Relays

.1 Construction: ac operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to protect against vibration, humidity and atmospheric contaminants.

.2 Operation: on-delay or off-delay.

.3 Potentiometer: self contained to provide time interval adjustment.

.4 Supply voltage: 120 V, ac, 60 Hz.

.5 Temperature range: minus 20°C to 60°C.

.6 Output contact rating: maximum voltage 300 V ac or dc. Current: EEMAC B300.

.7 Timing ranges: as required.

2.5 Instantaneous Trip Current Relays

.1 Enclosure: CSA Type 1

.2 Contacts: NO, NC automatic reset with adjustable tripping point.

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.

.4 Contact rating: EEMAC B600.

2.6 Operator Control Stations

.1 Enclosure: CSA Type 1, surface mounting:

2.7 Pushbuttons

.1 Heavy duty, Operator recessed, or flush, or mushroom type, as required. Black, with 1-NO and 1-NC contacts rated as required. Stop pushbuttons coloured red, provision for padlocking in depressed position.

2.8 Selector Switches

.1 Maintained or Spring return to center position, as required, heavy duty, operators standard wing lever, contact arrangement as required, rated 120 V, min 3 A, ac.

2.9 Indicating Lights

.1 Heavy duty, full voltage, push-to-test, lens colour: as required, supply voltage: 24 V, lamp, labels as required.

3. EXECUTION

3.1 Installation

.1 Install pushbutton stations, control and relay panels, control devices and interconnect.

3.2 Field Quality Control

.1 Perform all tests.

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Submit to Contract Administrator one copy of test results.

END OF SECTION

CABLE SCHEDULES

1. GENERAL

1.1 Description

.1 The Cable Schedule is provided as a guide only. The Cable Schedule presents general information on cable description, type and size, and reference location drawings. The Schedule and Drawings do not include all the cables required to complete the Work.

.2 Any cables shown on Drawings and not included in the Cable Schedule to be provided as part of the Work.

.3 Branch circuit wiring to lighting, receptacles, heaters, cathodic protection and grounding are not included in Schedules.

.4 Schedules are to be used in conjunction with Divisions 16 and 17, Single Line Diagrams, P&ID's, Instrument Index, Motor Control Schematics, Instrument Loop Diagrams, Cable Block Diagrams and location drawings.

.5 Cable Block Diagrams show Junction Boxes which would allow for the combining a number of control signals into one "Home Run" cable. These Junction Boxes are optional and are not reflected in the Cable Schedule. The Contractor has the option of supplying the Junction Boxes and using the modified wiring scheme.

.6 The ampacity of cables in tray is based on:

.1 One cable diameter spacing and one layer-100% of CEC Table 2,

.2 Random fill-50% of CEC Table 2.

.7 Provide cables and inter-connect packaged equipment based upon the manufacturer's requirements, if different from the cable schedule or drawings.

2. PRODUCTS

2.1 Not Used

3. EXECUTION

3.1 Not Used

END OF SECTION

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-SW1A		Cable Bus	XFM-H955A	SW1A	Power	4000 Amp 600V
P-SW1B		Cable Bus	XFM-H955B	SW1B	Power	4000 Amp 600V
P-TVSS-MCC1A	1x 3C TECK90 / AWG 4/0	Tray	MCC1A	TVSS-MCC1A	Power	
P-XFM-LP-A11	1x 3C TECK90 / AWG 3	Tray	MCC1A	XFM-LP-A11	Power	
P-LP-A11	1x 3C TECK90 / AWG 350	Tray	XFM-LP-A11	LP-A11	Power	
P-DP-A11	1x 3C TECK90 / AWG 350	Tray	MCC1A	DP-A11	Power	
P-DP-F01	1x 3C TECK90 / AWG 3/0	Tray	MCC1A	DP-F01	Power	
P-DP-F02	1x 3C TECK90 / AWG 4	Tray	DP-F01	DP-F02	Power	
P-LCP-F983A	1x 3C TECK90 / AWG 12	Tray	LCP-F055A	LCP-F983A	Power	
P-XFM-LP-F01	1x 3C TECK90 / AWG 4	Tray	DP-F02	XFM-LP-F01	Power	
P-LP-F01	1x 3C TECK90 / AWG 1	Tray	XFM-LP-F01	LP-F01	Power	
P-DP-A12	1x 3C TECK90 / AWG 8	Tray	MCC1B	DP-A12	Power	
P-DP-F03	1x 3C TECK90 / AWG 2	Tray	MCC1B	DP-F03	Power	
P-DP-F04	1x 3C TECK90 / AWG 10	Tray	DP-F03	DP-F04	Power	
P-MCC1A	6x 1C TECK90 / AWG 750	Conduit	SW1A	MCC1A	Power	
P-MCC2A	6x 1C TECK90 / AWG 1000	Conduit	SW1A	MCC2A	Power	
P-MCC3A	3x 1C TECK90 / AWG 1000	Conduit	SW1A	MCC3A	Power	
P-TVSS-MCC2A	1x 3C TECK90 / AWG 4/0	Tray	MCC2A	TVSS-MCC2A	Power	
P-XFM-LP-M11	1x 3C TECK90 / AWG 3	Tray	MCC2A	XFM-LP-M11	Power	
P-LP-M11	1x 3C TECK90 / AWG 2/0	Tray	XFM-LP-M11	LP-M11	Power	
P-UPS-H11	1x 3C TECK90 / AWG 4	Tray	LP-M11	UPS-H11	Power	
P-LP-UPS	1x 3C TECK90 / AWG 2/0	Tray	UPS-H11	LP-UPS	Power	
P-LCP-F01,	1x 2C TECK90 / AWG 12	Tray	LP-UPS	LCP-F01,	Power	
P-LCP-F01A,	1x 2C TECK90 / AWG 6	Tray	LP-UPS	LCP-F01A,	Power	
P-LCP-F02,	1x 2C TECK90 / AWG 12	Tray	LP-UPS	LCP-F02,	Power	
P-LCP-F02A,	1x 2C TECK90 / AWG 6	Tray	LP-UPS	LCP-F02A,	Power	
P-CP-H10,	1x 2C TECK90 / AWG 12	Tray	LP-UPS	CP-H10,	Power	
P-CP-H10A,	1x 2C TECK90 / AWG 12	Tray	LP-UPS	CP-H10A,	Power	
P-TJB-I21	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-I21	Power	
P-CP-C11,	1x 2C TECK90 / AWG 12	Tray	LP-UPS	CP-C11,	Power	
P-TJB-C11	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-C11	Power	
P-TJB-C12	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-C12	Power	
P-TJB-P11	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-P11	Power	
P-TJB-P12	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-P12	Power	
P-CP-O11	1x 2C TECK90 / AWG 12	Tray	LP-UPS	CP-O11	Power	
P-TJB-R21	1x 2C TECK90 / AWG 12	Tray	LP-UPS	TJB-R21	Power	
P-DP-P11	1x 3C TECK90 / AWG 6	Tray	MCC2A	DP-P11	Power	
P-DP-C11	1x 3C TECK90 / AWG 1/0	Tray	MCC2A	DP-C11	Power	
P-DP-C13	1x 3C TECK90 / AWG 12	Tray	MCC2A	DP-C13	Power	
P-MCC1B	6x 1C TECK90 / AWG 750	Conduit	SW1B	MCC1B	Power	
P-MCC2B	6x 1C TECK90 / AWG 1000	Conduit	SW1B	MCC2B	Power	
P-MCC3B	3x 1C TECK90 / AWG 1000	Conduit	SW1B	MCC3B	Power	
P-TVSS-MCC2B	1x 3C TECK90 / AWG 4/0	Tray	MCC2B	TVSS-MCC2B	Power	
P-XFM-LP-C11	1x 3C TECK90 / AWG 3	Tray	MCC2B	XFM-LP-C11	Power	
P-LP-C11	1x 2C TECK90 / AWG 800	Tray	XFM-LP-C11	LP-C11	Power	
P-XFM-LP-P11	1x 3C TECK90 / AWG 6	Tray	MCC2B	XFM-LP-P11	Power	
P-LP-P11	1x 2C TECK90 / AWG 1/0	Tray	XFM-LP-P11	LP-P11	Power	
P-DP-P12	1x 3C TECK90 / AWG 6	Tray	MCC2B	DP-P12	Power	
P-DP-C12	1x 3C TECK90 / AWG 3	Tray	MCC2B	DP-C12	Power	
P-TVSS-MCC3A	1x 3C TECK90 / AWG 4/0	Tray	MCC3A	TVSS-MCC3A	Power	
P-XFM-LP-R21	1x 3C TECK90 / AWG 6	Tray	MCC3A	XFM-LP-R21	Power	
P-LP-R21	1x 3C TECK90 / AWG 4	Tray	XFM-LP-R21	LP-R21	Power	
P-DP-R21	1x 3C TECK90 / AWG 300	Tray	MCC3A	DP-R21	Power	
P-DP-R22	1x 3C TECK90 / AWG 4	Tray	DP-R21	DP-R22	Power	
P-DP-F21	1x 3C TECK90 / AWG 1/0	Tray	DP-R21	DP-F21	Power	
P-TVSS-MCC3B	1x 3C TECK90 / AWG 4/0	Tray	MCC3B	TVSS-MCC3B	Power	
P-XFM-LP-A21	1x 3C TECK90 / AWG 1/0	Tray	MCC3B	XFM-LP-A21	Power	
P-LP-A21	1x 3C TECK90 / AWG 400	Tray	XFM-LP-A21	LP-A21	Power	
P-MCC4A	9x 1C TECK90 / AWG 700	Tray	SW10A	MCC4A	Power	
P-TVSS-MCC4A	1x 3C TECK90 / AWG 4/0	Tray	MCC4A	TVSS-MCC4A	Power	
P-XFM-LP-A31	1x 3C TECK90 / AWG 3	Tray	MCC4A	XFM-LP-A31	Power	
P-LP-A31	6x 1C TECK90 / AWG 300	Tray	XFM-LP-A31	LP-A31	Power	
P-UPS-32	1x 3C TECK90 / AWG 3	Tray	LP-A31	UPS-32	Power	
P-LP-UPS32	1x 3C TECK90 / AWG 12	Tray	UPS-32	LP-UPS32	Power	
P-CP-H31A	1x 3C TECK90 / AWG 12	Tray	LP-UPS32	CP-H31A	Power	
P-XFM-LP-H31	1x 3C TECK90 / AWG 1/0	Tray	MCC4A	XFM-LP-H31	Power	
P-LP-H31	1x 3C TECK90 / AWG 4/0	Tray	XFM-LP-H31	LP-H31	Power	
P-UPS-31	2x 3C TECK90 / AWG 250	Tray	LP-H31	UPS-31	Power	
P-LP-UPS31	1x 3C TECK90 / AWG 8	Tray	UPS-31	LP-UPS31	Power	
P-CP-H30,	1x 2C TECK90 / AWG 8	Tray	UPS-31	CP-H30,	Power	
P-CP-O30,	1x 2C TECK90 / AWG 6	Tray	LP-UPS31	CP-O30,	Power	
P-CP-P31,	1x 2C TECK90 / AWG 8	Tray	LP-UPS31	CP-P31,	Power	
P-CP-P32,	1x 2C TECK90 / AWG 8	Tray	LP-UPS31	CP-P32,	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-CP-P31A,	1x 2C TECK90 / AWG 8	Tray	LP-UPS31	CP-P31A,	Power	
P-XFM-PSU-O310A	1x 3C TECK90 / AWG 350	Tray	MCC4A	XFM-PSU-O310A	Power	
P-XFM-PSU-O330A	1x 3C TECK90 / AWG 350	Tray	MCC4A	XFM-PSU-O330A	Power	
P-DP-R31	1x 3C TECK90 / AWG 350	Tray	MCC4A	DP-R31	Power	
P-DP-H31	1x 3C TECK90 / AWG 300	Tray	MCC4A	DP-H31	Power	
P-DP-F31	1x 3C TECK90 / AWG 4	Tray	MCC4A	DP-F31	Power	
P-MCC4B	9x 1C TECK90 / AWG 700	Tray	SW10B	MCC4B	Power	
P-TVSS-MCC4B	1x 3C TECK90 / AWG 4/0	Tray	MCC4B	TVSS-MCC4B	Power	
P-XFM-LP-R31	1x 3C TECK90 / AWG 8	Tray	DP-R31	XFM-LP-R31	Power	
P-LP-R31	1x 3C TECK90 / AWG 4	Tray	XFM-LP-R31	LP-R31	Power	
P-XFM-PSU-O320A	2x 3C TECK90 / AWG 250	Tray	MCC4B	XFM-PSU-O320A	Power	
P-DP-H32	1x 3C TECK90 / AWG 400	Tray	MCC4B	DP-H32	Power	
P-XFM-LP-P31	1x 3C TECK90 / AWG 1/0	Tray	DP-H32	XFM-LP-P31	Power	
P-LP-P31	1x 3C TECK90 / AWG 3	Tray	XFM-LP-P31	LP-P31	Power	
P-CP-P31	1x 3C TECK90 / AWG 2/0	Tray	LP-P31	CP-P31	Power	
P-CP-P32	1x 3C TECK90 / AWG 2/0	Tray	LP-P31	CP-P32	Power	
P-DP-F32	1x 3C TECK90 / AWG 4	Tray	MCC4B	DP-F32	Power	
P-LCP-I001A	3x 1C TECK90 / AWG 3/0	Tray	SW1A	LCP-I001A	Power	
P-P-I001A	1x 3C TECK90 / AWG 350	Tray	LCP-I001A	P-I001A	Power	
P-LCP-I002A	3x 1C TECK90 / AWG 3/0	Tray	SW1B	LCP-I002A	Power	
P-P-I002A	2x 3C TECK90 / AWG 250	Tray	LCP-I002A	P-I002A	Power	
P-LCP-I003A	3x 1C TECK90 / AWG 3/0	Tray	SW1A	LCP-I003A	Power	
P-P-I003A	2x 3C TECK90 / AWG 250	Tray	LCP-I003A	P-I003A	Power	
P-LCP-I004A	3x 1C TECK90 / AWG 3/0	Tray	SW1B	LCP-I004A	Power	
P-P-I004A	2x 3C TECK90 / AWG 250	Tray	LCP-I004A	P-I004A	Power	
P-LCP-I005A	3x 1C TECK90 / AWG 3/0	Tray	SW1A	LCP-I005A	Power	
P-P-I005A	2x 3C TECK90 / AWG 250	Tray	LCP-I005A	P-I005A	Power	
P-SLG-I000C	1x 3C TECK90 / AWG 12	Tray	MCC1B	SLG-I000C	Power	
P-FV-I000A	1x 3C TECK90 / AWG 10	Tray	MCC1A	FV-I000A	Power	
P-FV-I000B	1x 3C TECK90 / AWG 10	Tray	MCC1B	FV-I000B	Power	
P-JB6-F31	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F31	Power	
P-FV-F101A	1x 3C RW90 / AWG 12	Conduit	JB6-F31	FV-F101A	Power	
P-JB6-F31	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F31	Power	
P-FV-F102A	1x 3C RW90 / AWG 12	Conduit	JB6-F31	FV-F102A	Power	
P-FV-F107A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F107A	Power	
P-FV-F106A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F106A	Power	
P-FCV-F103A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FCV-F103A	Power	
P-FV-F104A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F104A	Power	
P-FV-F105A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F105A	Power	
P-JB6-F31	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F31	Power	
P-FV-F201A	1x 3C RW90 / AWG 12	Conduit	JB6-F31	FV-F201A	Power	
P-JB6-F31	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F31	Power	
P-FV-F202A	1x 3C RW90 / AWG 12	Conduit	JB6-F31	FV-F202A	Power	
P-FV-F207A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F207A	Power	
P-FV-F206A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F206A	Power	
P-FCV-F203A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FCV-F203A	Power	
P-FV-F204A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F204A	Power	
P-FV-F205A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F205A	Power	
P-JB6-F32	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F32	Power	
P-FV-F301A	1x 3C RW90 / AWG 12	Conduit	JB6-F32	FV-F301A	Power	
P-JB6-F32	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F32	Power	
P-FV-F302A	1x 3C RW90 / AWG 12	Conduit	JB6-F32	FV-F302A	Power	
P-FV-F307A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F307A	Power	
P-FV-F306A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F306A	Power	
P-FCV-F303A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FCV-F303A	Power	
P-FV-F304A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F304A	Power	
P-FV-F305A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F305A	Power	
P-JB6-F32	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F32	Power	
P-FV-F401A	1x 3C RW90 / AWG 12	Conduit	JB6-F32	FV-F401A	Power	
P-JB6-F32	1x 3C TECK90 / AWG 12	Tray	DP-F31	JB6-F32	Power	
P-FV-F402A	1x 3C RW90 / AWG 12	Conduit	JB6-F32	FV-F402A	Power	
P-FV-F407A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F407A	Power	
P-FV-F406A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F406A	Power	
P-FCV-F403A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FCV-F403A	Power	
P-FV-F404A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F404A	Power	
P-FV-F405A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F405A	Power	
P-JB6-F33	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F33	Power	
P-FV-F501A	1x 3C RW90 / AWG 12	Conduit	JB6-F33	FV-F501A	Power	
P-JB6-F33	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F33	Power	
P-FV-F502A	1x 3C RW90 / AWG 12	Conduit	JB6-F33	FV-F502A	Power	
P-FV-F507A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F507A	Power	
P-FV-F506A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F506A	Power	
P-FCV-F503A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FCV-F503A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-FV-F504A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F504A	Power	
P-FV-F505A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F505A	Power	
P-JB6-F33	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F33	Power	
P-FV-F601A	1x 3C RW90 / AWG 12	Conduit	JB6-F33	FV-F601A	Power	
P-JB6-F33	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F33	Power	
P-FV-F602A	1x 3C RW90 / AWG 12	Conduit	JB6-F33	FV-F602A	Power	
P-FV-F607A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F607A	Power	
P-FV-F606A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F606A	Power	
P-FCV-F603A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FCV-F603A	Power	
P-FV-F604A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F604A	Power	
P-FV-F605A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F605A	Power	
P-JB6-F34	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F34	Power	
P-FV-F701A	1x 3C RW90 / AWG 12	Conduit	JB6-F34	FV-F701A	Power	
P-JB6-F34	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F34	Power	
P-FV-F702A	1x 3C RW90 / AWG 12	Conduit	JB6-F34	FV-F702A	Power	
P-FV-F707A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F707A	Power	
P-FV-F706A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F706A	Power	
P-FCV-F703A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FCV-F703A	Power	
P-FV-F704A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F704A	Power	
P-FV-F705A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F705A	Power	
P-JB6-F34	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F34	Power	
P-FV-F801A	1x 3C RW90 / AWG 12	Conduit	JB6-F34	FV-F801A	Power	
P-JB6-F34	1x 3C TECK90 / AWG 12	Tray	DP-F32	JB6-F34	Power	
P-FV-F802A	1x 3C RW90 / AWG 12	Conduit	JB6-F34	FV-F802A	Power	
P-FV-F807A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F807A	Power	
P-FV-F806A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F806A	Power	
P-FCV-F803A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FCV-F803A	Power	
P-FV-F804A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F804A	Power	
P-FV-F805A	1x 3C TECK90 / AWG 12	Tray	DP-F04	FV-F805A	Power	
P-FV-F912A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F912A	Power	
P-FV-F910A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F910A	Power	
P-LCP-F911A	3x 1C TECK90 / AWG 500	Tray	SW1A	LCP-F911A	Power	
P-P-F911A	1x 3C TECK90 / AWG 500	Tray	LCP-F911A	P-F911A	Power	
P-FCV-F911A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FCV-F911A	Power	
P-FV-F931A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F931A	Power	
P-FV-F922A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F922A	Power	
P-FV-F920A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-F920A	Power	
P-FV-F932A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F932A	Power	
P-LCP-F921A	3x 1C TECK90 / AWG 4/0	Tray	SW1B	LCP-F921A	Power	
P-P-F921A	1x 3C TECK90 / AWG 500	Tray	LCP-F921A	P-F921A	Power	
P-FCV-F921A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FCV-F921A	Power	
P-FV-F933A	1x 3C TECK90 / AWG 12	Tray	DP-F01	FV-F933A	Power	
P-FV-J992A	1x 3C TECK90 / AWG 12	Tray	DP-F03	FV-J992A	Power	
P-LCP-F010B	1x 2C TECK90 / AWG 12	Tray	LP-H31	LCP-F010B	Power	
P-BLW-F010A	3x 1C TECK90 / AWG 1/0	Tray	MCC4A	BLW-F010A	Power	
P-FV-F010A	1x 3C TECK90 / AWG 12	Tray	DP-H31	FV-F010A	Power	
P-LCP-F020B	1x 2C TECK90 / AWG 12	Tray	LP-H31	LCP-F020B	Power	
P-BLW-F020A	3x 1C TECK90 / AWG 1/0	Tray	MCC4B	BLW-F020A	Power	
P-FV-F020A	1x 3C TECK90 / AWG 12	Tray	DP-H32	FV-F020A	Power	
P-FT-F030A	2C Multi TECK90 / AWG 14	Tray	CP-H30.	FT-F030A	Power	
P-FV-F052A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F052A	Power	
P-FV-F051A	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-F051A	Power	
P-AT-F056A	4C Multi TECK90 / AWG 14	Tray	LCP-F01.	AT-F056A	Power	
P-LCP-J702A	1x 3C TECK90 / AWG 12	Tray	DP-F02	LCP-J702A	Power	
P-P-J702A	1x 3C TECK90 / AWG 12	Tray	LCP-J702A	P-J702A	Power	
P-FV-J702C	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-J702C	Power	
P-FV-J703C	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-J703C	Power	
P-LCP-J701A	1x 3C TECK90 / AWG 12	Tray	DP-F02	LCP-J701A	Power	
P-P-J701A	1x 3C TECK90 / AWG 12	Tray	LCP-J701A	P-J701A	Power	
P-FV-J701C	1x 3C TECK90 / AWG 12	Tray	DP-F02	FV-J701C	Power	
P-LCP-F055A	1x 3C TECK90 / AWG 12	Tray	DP-F01	LCP-F055A	Power	
P-P-F055A	1x 3C TECK90 / AWG 12	Tray	LCP-F055A	P-F055A	Power	
P-LCP-F981A	1x 3C TECK90 / AWG 12	Tray	DP-F03	LCP-F981A	Power	
P-P-F981A	1x 3C TECK90 / AWG 12	Tray	LCP-F981A	P-F981A	Power	
P-P-F982A	1x 3C TECK90 / AWG 12	Tray	LCP-F981A	P-F982A	Power	
P-LCP-F983A	1x 3C TECK90 / AWG 4	Tray	DP-F01	LCP-F983A	Power	
P-P-F983A	1x 3C TECK90 / AWG 4	Tray	LCP-F983A	P-F983A	Power	
P-LCP-F984A	1x 3C TECK90 / AWG 12	Tray	DP-F03	LCP-F984A	Power	
P-P-F984A	1x 3C TECK90 / AWG 12	Tray	LCP-F984A	P-F984A	Power	
P-LCP-C800A	1x 2C TECK90 / AWG 12	Tray	LP-C11	LCP-C800A	Power	
P-FV-C810B	1x 3C TECK90 / AWG 12	Tray	DP-C11	FV-C810B	Power	
P-FV-C820B	1x 3C TECK90 / AWG 12	Tray	DP-C12	FV-C820B	Power	
P-LCP-C840A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C840A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-P-C840A	1x 3C TECK90 / AWG 12	Tray	LCP-C840A	P-C840A	Power	
P-FT-C840A	4C Multi TECK90 / AWG 14	Tray	TJB-C12.	FT-C840A	Power	
P-LCP-C850A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C850A	Power	
P-P-C850A	1x 3C TECK90 / AWG 12	Tray	LCP-C850A	P-C850A	Power	
P-FT-C850A	4C Multi TECK90 / AWG 14	Tray	TJB-C12.	FT-C850A	Power	
P-LCP-C860A	1x 3C TECK90 / AWG 12	Tray	DP-C12	LCP-C860A	Power	
P-P-C860A	1x 3C TECK90 / AWG 12	Tray	LCP-C860A	P-C860A	Power	
P-FT-C860A	4C Multi TECK90 / AWG 14	Tray	TJB-C12.	FT-C860A	Power	
P-FV-C860C	1x 3C TECK90 / AWG 12	Tray	DP-C11	FV-C860C	Power	
P-FV-C860D	1x 3C TECK90 / AWG 12	Tray	DP-C12	FV-C860D	Power	
P-LT-C940B	4C Multi TECK90 / AWG 14	Tray	TJB-C11.	LT-C940B	Power	
P-LCP-C950A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C950A	Power	
P-P-C950A	1x 3C TECK90 / AWG 12	Tray	LCP-C950A	P-C950A	Power	
P-FT-C950A	4C Multi TECK90 / AWG 14	Tray	TJB-C11.	FT-C950A	Power	
P-LCP-C960A	1x 3C TECK90 / AWG 12	Tray	DP-C12	LCP-C960A	Power	
P-P-C960A	1x 3C TECK90 / AWG 12	Tray	LCP-C960A	P-C960A	Power	
P-FT-C960A	2C Multi TECK90 / AWG 14	Tray	TJB-C11.	FT-C960A	Power	
P-LCP-C970A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C970A	Power	
P-P-C970A	1x 3C TECK90 / AWG 12	Tray	LCP-C970A	P-C970A	Power	
P-FT-C970A	2C Multi TECK90 / AWG 14	Tray	TJB-C11.	FT-C970A	Power	
P-FV-C970D	1x 3C TECK90 / AWG 12	Tray	DP-C12	FV-C970D	Power	
P-FV-C970C	1x 3C TECK90 / AWG 12	Tray	DP-C11	FV-C970C	Power	
P-PCU-C020	1x 3C TECK90 / AWG 12	Tray	DP-C11	PCU-C020	Power	
P-BLW-C020A	1x 3C TECK90 / AWG 12	Tray	PCU-C020	BLW-C020A	Power	
P-CRN-C020C	1x 3C TECK90 / AWG 12	Tray	DP-C11	CRN-C020C	Power	
P-CFR-C020B	1x 3C TECK90 / AWG 12	Tray	DP-C11	CFR-C020B	Power	
P-PCU-C030	1x 3C TECK90 / AWG 12	Tray	DP-C12	PCU-C030	Power	
P-BLW-C030A	1x 3C TECK90 / AWG 12	Tray	PCU-C030	BLW-C030A	Power	
P-CRN-C030C	1x 3C TECK90 / AWG 12	Tray	DP-C12	CRN-C030C	Power	
P-CFR-C030B	1x 3C TECK90 / AWG 12	Tray	DP-C12	CFR-C030B	Power	
P-PPU-C021	1x 3C TECK90 / AWG 12	Tray	DP-C11	PPU-C021	Power	
P-MXR-C021A	1x 3C TECK90 / AWG 12	Tray	PPU-C021	MXR-C021A	Power	
P-FV-C021A	1x 3C TECK90 / AWG 12	Tray	PPU-C021	FV-C021A	Power	
P-LCP-C031	1x 3C TECK90 / AWG 12	Tray	DP-C12	LCP-C031	Power	
P-MXR-C031A	1x 3C TECK90 / AWG 12	Tray	PPU-C031	MXR-C031A	Power	
P-FV-C031A	1x 3C TECK90 / AWG 12	Tray	PPU-C031	FV-C031A	Power	
P-PPU-C001	1x 3C TECK90 / AWG 12	Tray	DP-C12	PPU-C001	Power	
P-P-C001A	1x 3C TECK90 / AWG 12	Tray	LCP-C001	P-C001A	Power	
P-WT-C001B	2C Multi TECK90 / AWG 14	Tray	LCP-C001	WT-C001B	Power	
P-LCP-C061A	1x 3C TECK90 / AWG 8	Tray	DP-C11	LCP-C061A	Power	
P-P-C061A	1x 3C TECK90 / AWG 12	Tray	LCP-C061A	P-C061A	Power	
P-LCP-C062A	1x 3C TECK90 / AWG 10	Tray	DP-C12	LCP-C062A	Power	
P-P-C062A	1x 3C TECK90 / AWG 12	Tray	LCP-C062A	P-C062A	Power	
P-LCP-C063A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C063A	Power	
P-P-C063A	1x 3C TECK90 / AWG 12	Tray	LCP-C063A	P-C063A	Power	
P-FV-C064B	1x 2C TECK90 / AWG 12	Tray	LP-C11	FV-C064B	Power	
P-FV-C065B	1x 2C TECK90 / AWG 12	Tray	LP-C11	FV-C065B	Power	
P-LCP-C071A	1x 3C TECK90 / AWG 12	Tray	DP-C11	LCP-C071A	Power	
P-P-C071A	1x 3C TECK90 / AWG 12	Tray	LCP-C071A	P-C071A	Power	
P-FV-C073A	1x 2C TECK90 / AWG 12	Tray	LP-C11	FV-C073A	Power	
P-LCP-C072A	1x 3C TECK90 / AWG 12	Tray	DP-C12	LCP-C072A	Power	
P-P-C072A	1x 3C TECK90 / AWG 12	Tray	LCP-C072A	P-C072A	Power	
P-MXR-O210A	1x 3C TECK90 / AWG 12	Tray	DP-H31	MXR-O210A	Power	
P-MXR-O230A	1x 3C TECK90 / AWG 12	Tray	DP-H32	MXR-O230A	Power	
P-LCP-O11	1x 3C TECK90 / AWG 4/0	Tray	MCC2A	LCP-O11	Power	
P-CP-O11	1x 2C TECK90 / AWG 6	Tray	LP-UPS	CP-O11	Power	
P-PV-O010A	1x 3C TECK90 / AWG 1/0	Tray	DP-C13	PV-O010A	Power	
P-PT-O010A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	PT-O010A	Power	
P-LT-O010A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	LT-O010A	Power	
P-FV-O010A	1x 3C TECK90 / AWG 12	Tray	PV-O010A	FV-O010A	Power	
P-FV-O021A	1x 3C TECK90 / AWG 12	Tray	PV-O010A	FV-O021A	Power	
P-FV-O011A	1x 3C TECK90 / AWG 12	Tray	PV-O010A	FV-O011A	Power	
P-HTR-O012A	1x 3C TECK90 / AWG 6	Tray	PV-O010A	HTR-O012A	Power	
P-HTR-O022A	1x 3C TECK90 / AWG 6	Tray	PV-O010A	HTR-O022A	Power	
P-TT-O012A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	TT-O012A	Power	
P-PT-O015A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	PT-O015A	Power	
P-FV-O015A	1x 3C TECK90 / AWG 12	Tray	PV-O010A	FV-O015A	Power	
P-LCP-O020A	1x 3C TECK90 / AWG 12	Tray	DP-C12	LCP-O020A	Power	
P-PT-O020A	2C Multi TECK90 / AWG 14	Tray	LCP-O020A	PT-O020A	Power	
P-LT-O020A	2C Multi TECK90 / AWG 14	Tray	LCP-O020A	LT-O020A	Power	
P-FV-O020A	1x 3C TECK90 / AWG 12	Tray	LCP-O020A	FV-O020A	Power	
P-AT-O032A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O032A	Power	
P-LCP-O050	1x 3C TECK90 / AWG 8	Tray	PSU-O310A	LCP-O050	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-LCP-O050	1x 3C TECK90 / AWG 8	Tray	PSU-O330A	LCP-O050	Power	
P-CMP-O052A	1x 3C TECK90 / AWG 12	Tray	LCP-O050	CMP-O052A	Power	
P-CMP-O053A	1x 3C TECK90 / AWG 12	Tray	LCP-O050	CMP-O053A	Power	
P-BV-O050A	1x 2C TECK90 / AWG 12	Tray	LCP-O050	BV-O050A	Power	
P-DES-O051A	1x 2C TECK90 / AWG 12	Tray	LCP-O050	DES-O051A	Power	
P-FV-O051A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FV-O051A	Power	
P-AT-O051A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O051A	Power	
P-FV-O119A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FV-O119A	Power	
p-FM-O115A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	FM-O115A	power	
P-FT-O112A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	FT-O112A	Power	
P-FCV-O112A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FCV-O112A	Power	
P-AT-O112A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	AT-O112A	Power	
P-FV-O112B	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FV-O112B	Power	
P-AT-O110A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O110A	Power	
P-AT-O110B	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O110B	Power	
P-FV-O139A	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FV-O139A	Power	
P-FT-O132A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	FT-O132A	Power	
P-FCV-O132A	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FCV-O132A	Power	
P-AT-O132A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	AT-O132A	Power	
P-FV-O132B	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FV-O132B	Power	
P-AT-O130A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O130A	Power	
P-AT-O130B	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O130B	Power	
P-LCP-O110A.	1x 2C TECK90 / AWG 12	Tray	CP-O30.	LCP-O110A.	Power	
P-AL-O001A	1x 2C TECK90 / AWG 12	Tray	LCP-O110A.	AL-O001A	Power	
P-AL-O001B	1x 2C TECK90 / AWG 12	Tray	LCP-O110A.	AL-O001B	Power	
P-AL-O001C	1x 2C TECK90 / AWG 12	Tray	LCP-O110A.	AL-O001C	Power	
P-FV-O159A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FV-O159A	Power	
p-FM-O155A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	FM-O155A	power	
P-FT-O152A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	FT-O152A	Power	
P-FCV-O152A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FCV-O152A	Power	
P-AT-O152A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	AT-O152A	Power	
P-FV-O152A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FV-O152A	Power	
P-AT-O150A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O150A	Power	
P-FV-O201A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FV-O201A	Power	
P-FV-O202A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FV-O202A	Power	
P-FT-O216A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O216A	Power	
P-FCV-O216A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O216A	Power	
P-FT-O217A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O217A	Power	
P-FCV-O217A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O217A	Power	
P-FT-O218A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O218A	Power	
P-FCV-O218A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O218A	Power	
P-FT-O236A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O236A	Power	
P-FCV-O236A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O236A	Power	
P-FT-O237A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O237A	Power	
P-FCV-O237A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O237A	Power	
P-FT-O238A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	FT-O238A	Power	
P-FCV-O238A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FCV-O238A	Power	
P-SLG-O210A	1x 3C TECK90 / AWG 12	Tray	DP-H31	SLG-O210A	Power	
P-SLG-O210B	1x 3C TECK90 / AWG 12	Tray	DP-F31	SLG-O210B	Power	
P-SLG-O210C	1x 3C TECK90 / AWG 12	Tray	DP-F31	SLG-O210C	Power	
P-MXR-C701A	1x 3C TECK90 / AWG 12	Tray	MCC4A	MXR-C701A	Power	
P-LT-C701A	2C Multi TECK90 / AWG 14	Tray	TJB-F31.	LT-C701A	Power	
P-SLG-O230A	1x 3C TECK90 / AWG 12	Tray	DP-F32	SLG-O230A	Power	
P-SLG-O230B	1x 3C TECK90 / AWG 12	Tray	DP-F32	SLG-O230B	Power	
P-SLG-O230C	1x 3C TECK90 / AWG 12	Tray	DP-F32	SLG-O230C	Power	
P-MXR-C702A	1x 3C TECK90 / AWG 12	Tray	MCC4B	MXR-C702A	Power	
P-LT-C702A	2C Multi TECK90 / AWG 14	Tray	TJB-F32.	LT-C702A	Power	
P-AT-O501A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O501A	Power	
P-FV-O521A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FV-O521A	Power	
P-LCP-O510A	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-O510A	Power	
P-FCV-O510A	1x 2C TECK90 / AWG 12	Tray	LCP-O510A	FCV-O510A	Power	
P-HTR-O510A	1x 3C TECK90 / AWG 12	Tray	LCP-O510A	HTR-O510A	Power	
P-CDU-O510A	1x 3C TECK90 / AWG 12	Tray	LCP-O510A	CDU-O510A	Power	
P-BLW-O510A	1x 3C TECK90 / AWG 12	Tray	LCP-O510A	BLW-O510A	Power	
P-PT-O510B	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	PT-O510B	Power	
P-AT-O510A	2C Multi TECK90 / AWG 14	Tray	LCP-O510A	AT-O510A	Power	
P-LCP-O520A	1x 3C TECK90 / AWG 8	Tray	DP-H32	LCP-O520A	Power	
P-FCV-O520A	1x 2C TECK90 / AWG 12	Tray	LCP-O520A	FCV-O520A	Power	
P-HTR-O520A	1x 3C TECK90 / AWG 12	Tray	LCP-O520A	HTR-O520A	Power	
P-CDU-O520A	1x 3C TECK90 / AWG 12	Tray	LCP-O520A	CDU-O520A	Power	
P-BLW-O520A	1x 3C TECK90 / AWG 12	Tray	LCP-O520A	BLW-O520A	Power	
P-AT-O520A	2C Multi TECK90 / AWG 14	Tray	LCP-O520A	AT-O520A	Power	
P-AT-O520B	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O520B	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-AT-O505A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O505A	Power	
P-FV-O523A	1x 2C TECK90 / AWG 12	Tray	CP-O30.	FV-O523A	Power	
P-LCP-O530A	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-O530A	Power	
P-FCV-O530A	1x 2C TECK90 / AWG 12	Tray	LCP-O530A	FCV-O530A	Power	
P-HTR-O530A	1x 3C TECK90 / AWG 12	Tray	LCP-O530A	HTR-O530A	Power	
P-CDU-O530A	1x 3C TECK90 / AWG 12	Tray	LCP-O530A	CDU-O530A	Power	
P-BLW-O530A	1x 3C TECK90 / AWG 12	Tray	LCP-O530A	BLW-O530A	Power	
P-AT-O530A	2C Multi TECK90 / AWG 14	Tray	LCP-O530A	AT-O530A	Power	
P-P-O401A	1x 3C TECK90 / AWG 12	Tray	MCC1A	P-O401A	Power	
P-P-O402A	1x 3C TECK90 / AWG 12	Tray	MCC1A	P-O402A	Power	
P-P-O403A	1x 2C TECK90 / AWG 12	Tray	MCC1B	P-O403A	Power	
P-AT-O404A	2C Multi TECK90 / AWG 14	Tray	LCP-F01.	AT-O404A	Power	
P-FV-O410A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FV-O410A	Power	
P-FT-O410A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	FT-O410A	Power	
P-FV-O411A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FV-O411A	Power	
P-FT-O411A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	FT-O411A	Power	
P-P-O411A	1x 3C TECK90 / AWG 12	Tray	PSU-O310A	P-O411A	Power	
P-FCV-O411A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	FCV-O411A	Power	
P-FV-O420A	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FV-O420A	Power	
P-FT-O420A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	FT-O420A	Power	
P-FV-O421A	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FV-O421A	Power	
P-FT-O421A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	FT-O421A	Power	
P-P-O421A	1x 3C TECK90 / AWG 12	Tray	PSU-O320A	P-O421A	Power	
P-FCV-O421A	1x 2C TECK90 / AWG 12	Tray	PSU-O320A	FCV-O421A	Power	
P-FV-O430A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FV-O430A	Power	
P-FT-O430A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	FT-O430A	Power	
P-FV-O431A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FV-O431A	Power	
P-FT-O431A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	FT-O431A	Power	
P-P-O431A	1x 3C TECK90 / AWG 12	Tray	PSU-O330A	P-O431A	Power	
P-FCV-O431A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	FCV-O431A	Power	
P-PSU-O310A	1x 3C TECK90 / AWG 350	Tray	XFM-PSU-O310A	PSU-O310A	Power	
P-PSU-O310A	1x 2C TECK90 / AWG 6	Tray	CP-O30.	PSU-O310A	Power	
P-PSU-O320A	1x 3C TECK90 / AWG 350	Tray	XFM-PSU-O320A	PSU-O320A	Power	
P-PSU-O320A	1x 2C TECK90 / AWG 6	Tray	CP-O30.	PSU-O320A	Power	
P-PSU-O330A	1x 3C TECK90 / AWG 350	Tray	XFM-PSU-O330A	PSU-O330A	Power	
P-PSU-O330A	1x 2C TECK90 / AWG 6	Tray	CP-O30.	PSU-O330A	Power	
P-SP-O220A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	SP-O220A	Power	
P-SP-O225A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	SP-O225A	Power	
P-AT-O221A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O221A	Power	
P-AT-O226A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O226A	Power	
P-SP-O240A	1x 2C TECK90 / AWG 12	Tray	PSU-O310A	SP-O240A	Power	
P-SP-O245A	1x 2C TECK90 / AWG 12	Tray	PSU-O330A	SP-O245A	Power	
P-AT-O241A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O241A	Power	
P-AT-O246A	2C Multi TECK90 / AWG 14	Tray	CP-O30.	AT-O246A	Power	
P-AT-O001A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O001A	Power	
P-AT-O001A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O001A	Power	
P-AT-O002A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O002A	Power	
P-AT-O002A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O002A	Power	
P-AT-O003A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O003A	Power	
P-AT-O003A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O003A	Power	
P-AT-O004A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O004A	Power	
P-AT-O004A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O004A	Power	
P-AT-O005A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O005A	Power	
P-AT-O006A	2C Multi TECK90 / AWG 14	Tray	LCP-R21.	AT-O006A	Power	
P-CMP-O007A	1x 3C TECK90 / AWG 12	Tray	DP-F21	CMP-O007A	Power	
P-FV-O008A	1x 2C TECK90 / AWG 12	Tray	DP-F21	FV-O008A	Power	
P-MXR-O009A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O009A	Power	
P-SCR-O010A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SCR-O010A	Power	
P-LCP-O011A	1x 2C TECK90 / AWG 12	Tray	DP-F21	LCP-O011A	Power	
P-LCP-O012A	1x 2C TECK90 / AWG 12	Tray	DP-F21	LCP-O012A	Power	
P-P-O013A	1x 3C TECK90 / AWG 12	Tray	DP-F21	P-O013A	Power	
P-P-O014A	1x 3C TECK90 / AWG 12	Tray	DP-F21	P-O014A	Power	
P-P-O015A	1x 3C TECK90 / AWG 12	Tray	DP-F21	P-O015A	Power	
P-P-O016A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O016A	Power	
P-P-O017A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O017A	Power	
P-P-O018A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O018A	Power	
P-P-O019A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O019A	Power	
P-P-O020A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O020A	Power	
P-P-O021A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O021A	Power	
P-P-O022A	1x 3C TECK90 / AWG 12	Tray	DP-F21	P-O022A	Power	
P-P-O023A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O023A	Power	
P-P-O024A	1x 3C TECK90 / AWG 12	Tray	DP-F21	P-O024A	Power	
P-BLW-O025A	1x 2C TECK90 / AWG 12	Tray	DP-F21	BLW-O025A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-P-O026A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O026A	Power	
P-P-O027A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O027A	Power	
P-P-O028A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O028A	Power	
P-P-O029A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O029A	Power	
P-P-O030A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O030A	Power	
P-P-O031A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O031A	Power	
P-SV-O032A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O032A	Power	
P-SV-O033A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O033A	Power	
P-SV-O034A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O034A	Power	
P-SV-O035A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O035A	Power	
P-SV-O036A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O036A	Power	
P-SV-O037A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O037A	Power	
P-SV-O038A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O038A	Power	
P-SV-O039A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O039A	Power	
P-SV-O040A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O040A	Power	
P-SV-O041A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O041A	Power	
P-SV-O042A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O042A	Power	
P-SV-O043A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O043A	Power	
P-SV-O044A	2C Multi TECK90 / AWG 14	Tray	DP-F21	SV-O044A	Power	
P-MXR-O045A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O045A	Power	
P-MXR-O046A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O046A	Power	
P-MXR-O047A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O047A	Power	
P-MXR-O048A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O048A	Power	
P-MXR-O049A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O049A	Power	
P-MXR-O050A	1x 2C TECK90 / AWG 12	Tray	DP-F21	MXR-O050A	Power	
P-P-O051A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O051A	Power	
P-P-O052A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O052A	Power	
P-P-O053A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O053A	Power	
P-P-O054A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O054A	Power	
P-P-O055A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O055A	Power	
P-P-O056A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O056A	Power	
P-P-O057A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O057A	Power	
P-P-O058A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O058A	Power	
P-P-O059A	1x 2C TECK90 / AWG 12	Tray	DP-F21	P-O059A	Power	
P-SV-O060A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O060A	Power	
P-SV-O061A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O061A	Power	
P-SV-O062A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O062A	Power	
P-SV-O063A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O063A	Power	
P-SV-O064A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O064A	Power	
P-SV-O065A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O065A	Power	
P-SV-O066A	1x 2C TECK90 / AWG 12	Tray	DP-F21	SV-O066A	Power	
P-LCP-O067A	1x 3C TECK90 / AWG 12	Tray	DP-F21	LCP-O067A	Power	
P-LCP-O068A	1x 3C TECK90 / AWG 3	Tray	DP-F21	LCP-O068A	Power	
P-LCP-O069A	1x 2C TECK90 / AWG 12	Tray	DP-F21	LCP-O069A	Power	
P-SLG-R100A	1x 3C TECK90 / AWG 12	Tray	DP-R21	SLG-R100A	Power	
P-SLG-R200A	1x 3C TECK90 / AWG 12	Tray	DP-R21	SLG-R200A	Power	
P-SLG-R300A	1x 3C TECK90 / AWG 12	Tray	DP-R22	SLG-R300A	Power	
P-SLG-R400A	1x 3C TECK90 / AWG 12	Tray	DP-R22	SLG-R400A	Power	
P-FV-R100A	1x 3C TECK90 / AWG 12	Tray	DP-R21	FV-R100A	Power	
P-P-R100C	1x 3C TECK90 / AWG 12	Tray	MCC3A	P-R100C	Power	
P-FV-R200A	1x 3C TECK90 / AWG 12	Tray	DP-R21	FV-R200A	Power	
P-P-R200C	1x 3C TECK90 / AWG 12	Tray	MCC3A	P-R200C	Power	
P-FV-R300A	1x 3C TECK90 / AWG 12	Tray	DP-R22	FV-R300A	Power	
P-P-R300C	1x 3C TECK90 / AWG 12	Tray	MCC3B	P-R300C	Power	
P-AY-R300C	2x Pair TECK90 / AWG 16	Tray	MCC3B	AY-R300C	Power	
P-FV-R400A	1x 3C TECK90 / AWG 12	Tray	DP-R22	FV-R400A	Power	
P-P-R400C	1x 3C TECK90 / AWG 12	Tray	MCC3B	P-R400C	Power	
P-LCP-R001C	1x 3C TECK90 / AWG 12	Tray	DP-R21	LCP-R001C	Power	
P-LCP-R001C	1x CAT5e / AWG 22	Tray	LCP-R21A	LCP-R001C	Power	
P-MXR-R001C	1x 3C TECK90 / AWG 12	Tray	LCP-R001C	MXR-R001C	Power	
P-SP-R010A	1x 3C TECK90 / AWG 12	Tray	LP-R21	SP-R010A	Power	
P-P-R021A	1x 3C TECK90 / AWG 1/0	Tray	MCC3A	P-R021A	Power	
P-P-R022A	1x 3C TECK90 / AWG 1/0	Tray	MCC3B	P-R022A	Power	
P-P-R023A	1x 3C TECK90 / AWG 1/0	Tray	MCC3A	P-R023A	Power	
P-LCP-R500A	1x 3C TECK90 / AWG 12	Tray	DP-R21	LCP-R500A	Power	
P-M-R500A	1x 3C TECK90 / AWG 12	Tray	LCP-R500A	M-R500A	Power	
P-LCP-R600A	1x 3C TECK90 / AWG 12	Tray	DP-R22	LCP-R600A	Power	
P-M-R600A	1x 3C TECK90 / AWG 12	Tray	LCP-R600A	M-R600A	Power	
P-FV-R710A	1x 3C TECK90 / AWG 12	Tray	DP-R21	FV-R710A	Power	
P-P-R710B	1x 3C TECK90 / AWG 12	Tray	MCC3A	P-R710B	Power	
P-HS-R710B	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R710B	Power	
P-AY-R710B	2C Multi TECK90 / AWG 14	Tray	MCC3A	AY-R710B	Power	
P-LCP-R710C	1x 3C TECK90 / AWG 12	Tray	DP-R21	LCP-R710C	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-LCP-R710C	1x 2C TECK90 / AWG 12	Tray	LP-R21	LCP-R710C	Power	
P-MXR-R710C	1x 3C TECK90 / AWG 12	Tray	LCP-R710C	MXR-R710C	Power	
P-P-R720B	1x 3C TECK90 / AWG 12	Tray	MCC3B	P-R720B	Power	
P-HS-R720B	3C Multi TECK90 / AWG 14	Tray	MCC3B	HS-R720B	Power	
P-AY-R720B	2C Multi TECK90 / AWG 14	Tray	MCC3B	AY-R720B	Power	
P-LCP-R720C	1x 3C TECK90 / AWG 12	Tray	DP-R22	LCP-R720C	Power	
P-LCP-R720C	1x 2C TECK90 / AWG 12	Tray	LP-R21	LCP-R720C	Power	
P-MXR-R720C	1x 3C TECK90 / AWG 12	Tray	LCP-R720C	MXR-R720C	Power	
P-HS-R720C	3C Multi TECK90 / AWG 14	Tray	LCP-R720C	HS-R720C	Power	
P-FV-R720A	1x 3C TECK90 / AWG 12	Tray	DP-R22	FV-R720A	Power	
P-P-R901	1x 3C TECK90 / AWG 12	Tray	MCC3A	P-R901	Power	
P-HS-R901	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R901	Power	
P-AE-R901	2C Multi TECK90 / AWG 14	Tray	MCC3A	AE-R901	Power	
P-P-R902	1x 3C TECK90 / AWG 12	Tray	MCC3B	P-R902	Power	
P-HS-R902	3C Multi TECK90 / AWG 14	Tray	MCC3B	HS-R902	Power	
P-AE-R902	2C Multi TECK90 / AWG 14	Tray	MCC3B	AE-R902	Power	
P-FIT-R924B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	FIT-R924B	Power	
P-FIT-R924B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	FIT-R924B	Power	
P-P-R921	1x 3C TECK90 / AWG 10	Tray	MCC3A	P-R921	Power	
P-HS-R921	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R921	Power	
P-AE-R921	2C Multi TECK90 / AWG 14	Tray	MCC3A	AE-R921	Power	
P-P-R922	1x 3C TECK90 / AWG 10	Tray	MCC3B	P-R922	Power	
P-HS-R922	3C Multi TECK90 / AWG 14	Tray	MCC3B	HS-R922	Power	
P-AE-R922	2C Multi TECK90 / AWG 14	Tray	MCC3B	AE-R922	Power	
P-P-R923	1x 3C TECK90 / AWG 10	Tray	MCC3A	P-R923	Power	
P-HS-R923	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R923	Power	
P-AE-R923	2C Multi TECK90 / AWG 14	Tray	MCC3A	AE-R923	Power	
P-TT-I011A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	TT-I011A	Power	
P-AT-I024B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	AT-I024B	Power	
P-PT-I011B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	PT-I011B	Power	
P-TT-I012A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	TT-I012A	Power	
P-PT-I012B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	PT-I012B	Power	
P-AT-I027B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	AT-I027B	Power	
P-P-I013A	1x 3C TECK90 / AWG 10	Tray	MCC1A	P-I013A	Power	
P-P-I014A	1x 3C TECK90 / AWG 10	Tray	MCC1A	P-I014A	Power	
P-P-I015A	1x 3C TECK90 / AWG 10	Tray	MCC1B	P-I015A	Power	
P-FV-I014D	1x 3C TECK90 / AWG 12	Tray	DP-A11	FV-I014D	Power	
P-FV-I014E	1x 3C TECK90 / AWG 12	Tray	DP-A11	FV-I014E	Power	
P-AT-I025B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	AT-I025B	Power	
P-AT-I026B	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	AT-I026B	Power	
P-FT-P100A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P100A	Power	
P-FCV-P100A	1x 3C TECK90 / AWG 12	Tray	DP-A11	FCV-P100A	Power	
P-FT-P200A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P200A	Power	
P-FCV-P200A	1x 3C TECK90 / AWG 12	Tray	DP-A11	FCV-P200A	Power	
P-FT-P300A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P300A	Power	
P-FCV-P300A	1x 3C TECK90 / AWG 12	Tray	DP-A11	FCV-P300A	Power	
P-FT-P400A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P400A	Power	
P-FCV-P400A	1x 3C TECK90 / AWG 12	Tray	DP-A11	FCV-P400A	Power	
P-FT-P500A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P500A	Power	
P-FCV-P500A	1x 3C TECK90 / AWG 12	Tray	DP-A12	FCV-P500A	Power	
P-FT-P600A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P600A	Power	
P-FCV-P600A	1x 3C TECK90 / AWG 12	Tray	DP-A12	FCV-P600A	Power	
P-FT-P700A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P700A	Power	
P-FCV-P700A	1x 3C TECK90 / AWG 12	Tray	DP-A12	FCV-P700A	Power	
P-FT-P800A	2C Multi TECK90 / AWG 14	Tray	TJB-A11.	FT-P800A	Power	
P-FCV-P800A	1x 3C TECK90 / AWG 12	Tray	DP-A12	FCV-P800A	Power	
P-LCP-P31	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-P31	Power	
P-FLC-P101A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P101A	Power	
P-FLC-P101A	1x 3C RW90 / AWG 12	Conduit	FLC-P101A	FLC-P101A	Power	
P-FLC-P102A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P102A	Power	
P-FLC-P102A	1x 3C RW90 / AWG 12	Conduit	FLC-P102A	FLC-P102A	Power	
P-FLC-P103A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P103A	Power	
P-FLC-P103A	1x 3C RW90 / AWG 12	Conduit	FLC-P103A	FLC-P103A	Power	
P-FLC-P104A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P104A	Power	
P-FLC-P104A	1x 3C RW90 / AWG 12	Conduit	FLC-P104A	FLC-P104A	Power	
P-FLC-P105A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P105A	Power	
P-FLC-P105A	1x 3C RW90 / AWG 12	Conduit	FLC-P105A	FLC-P105A	Power	
P-FLC-P106A	1x 3C RW90 / AWG 12	Conduit	LCP-P31	FLC-P106A	Power	
P-FLC-P106A	1x 3C RW90 / AWG 12	Conduit	FLC-P106A	FLC-P106A	Power	
P-DF-P100A	1x 3C TECK90 / AWG 12	Tray	LCP-P31	DF-P100A	Power	
P-LT-P100A	2C Multi TECK90 / AWG 14	Tray	LCP-P31	LT-P100A	Power	
P-SLG-P140A	1x 2C TECK90 / AWG 12	Tray	MCC4A	SLG-P140A	Power	
P-FV-P110A	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P110A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-FV-P110B	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P110B	Power	
P-LCP-P32	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-P32	Power	
P-FLC-P201A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P201A	Power	
P-FLC-P201A	1x 3C RW90 / AWG 12	Conduit	FLC-P201A	FLC-P201A	Power	
P-FLC-P202A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P202A	Power	
P-FLC-P202A	1x 3C RW90 / AWG 12	Conduit	FLC-P202A	FLC-P202A	Power	
P-FLC-P203A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P203A	Power	
P-FLC-P203A	1x 3C RW90 / AWG 12	Conduit	FLC-P203A	FLC-P203A	Power	
P-FLC-P204A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P204A	Power	
P-FLC-P204A	1x 3C RW90 / AWG 12	Conduit	FLC-P204A	FLC-P204A	Power	
P-FLC-P205A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P205A	Power	
P-FLC-P205A	1x 3C RW90 / AWG 12	Conduit	FLC-P205A	FLC-P205A	Power	
P-FLC-P206A	1x 3C RW90 / AWG 12	Conduit	LCP-P32	FLC-P206A	Power	
P-FLC-P206A	1x 3C RW90 / AWG 12	Conduit	FLC-P206A	FLC-P206A	Power	
P-DF-P200A	1x 3C TECK90 / AWG 12	Tray	LCP-P32	DF-P200A	Power	
P-SLG-P240A	1x 2C TECK90 / AWG 12	Tray	MCC4A	SLG-P240A	Power	
P-FV-P210A	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P210A	Power	
P-FV-P210B	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P210B	Power	
P-LCP-P33	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-P33	Power	
P-FLC-P301A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P301A	Power	
P-FLC-P301A	1x 3C RW90 / AWG 12	Conduit	FLC-P301A	FLC-P301A	Power	
P-FLC-P302A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P302A	Power	
P-FLC-P302A	1x 3C RW90 / AWG 12	Conduit	FLC-P302A	FLC-P302A	Power	
P-FLC-P303A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P303A	Power	
P-FLC-P303A	1x 3C RW90 / AWG 12	Conduit	FLC-P303A	FLC-P303A	Power	
P-FLC-P304A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P304A	Power	
P-FLC-P304A	1x 3C RW90 / AWG 12	Conduit	FLC-P304A	FLC-P304A	Power	
P-FLC-P305A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P305A	Power	
P-FLC-P305A	1x 3C RW90 / AWG 12	Conduit	FLC-P305A	FLC-P305A	Power	
P-FLC-P306A	1x 3C RW90 / AWG 12	Conduit	LCP-P33	FLC-P306A	Power	
P-FLC-P306A	1x 3C RW90 / AWG 12	Conduit	FLC-P306A	FLC-P306A	Power	
P-DF-P300A	1x 3C TECK90 / AWG 12	Tray	LCP-P33	DF-P300A	Power	
P-SLG-P340A	1x 2C TECK90 / AWG 12	Tray	MCC4A	SLG-P340A	Power	
P-FV-P310A	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P310A	Power	
P-FV-P310B	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P310B	Power	
P-LCP-P34	1x 3C TECK90 / AWG 8	Tray	DP-H31	LCP-P34	Power	
P-FLC-P401A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P401A	Power	
P-FLC-P401A	1x 3C RW90 / AWG 12	Conduit	FLC-P401A	FLC-P401A	Power	
P-FLC-P402A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P402A	Power	
P-FLC-P402A	1x 3C RW90 / AWG 12	Conduit	FLC-P402A	FLC-P402A	Power	
P-FLC-P403A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P403A	Power	
P-FLC-P403A	1x 3C RW90 / AWG 12	Conduit	FLC-P403A	FLC-P403A	Power	
P-FLC-P404A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P404A	Power	
P-FLC-P404A	1x 3C RW90 / AWG 12	Conduit	FLC-P404A	FLC-P404A	Power	
P-FLC-P405A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P405A	Power	
P-FLC-P405A	1x 3C RW90 / AWG 12	Conduit	FLC-P405A	FLC-P405A	Power	
P-FLC-P406A	1x 3C RW90 / AWG 12	Conduit	LCP-P34	FLC-P406A	Power	
P-FLC-P406A	1x 3C RW90 / AWG 12	Conduit	FLC-P406A	FLC-P406A	Power	
P-DF-P400A	1x 3C TECK90 / AWG 12	Tray	LCP-P34	DF-P400A	Power	
P-SLG-P440A	1x 2C TECK90 / AWG 12	Tray	MCC4A	SLG-P440A	Power	
P-FV-P410A	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P410A	Power	
P-FV-P410B	1x 2C TECK90 / AWG 12	Tray	CP-P31	FV-P410B	Power	
P-LCP-P35	1x 3C TECK90 / AWG 8	Tray	DP-H32	LCP-P35	Power	
P-FLC-P501A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P501A	Power	
P-FLC-P501A	1x 3C RW90 / AWG 12	Conduit	FLC-P501A	FLC-P501A	Power	
P-FLC-P502A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P502A	Power	
P-FLC-P502A	1x 3C RW90 / AWG 12	Conduit	FLC-P502A	FLC-P502A	Power	
P-FLC-P503A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P503A	Power	
P-FLC-P503A	1x 3C RW90 / AWG 12	Conduit	FLC-P503A	FLC-P503A	Power	
P-FLC-P504A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P504A	Power	
P-FLC-P504A	1x 3C RW90 / AWG 12	Conduit	FLC-P504A	FLC-P504A	Power	
P-FLC-P505A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P505A	Power	
P-FLC-P505A	1x 3C RW90 / AWG 12	Conduit	FLC-P505A	FLC-P505A	Power	
P-FLC-P506A	1x 3C RW90 / AWG 12	Conduit	LCP-P35	FLC-P506A	Power	
P-FLC-P506A	1x 3C RW90 / AWG 12	Conduit	FLC-P506A	FLC-P506A	Power	
P-DF-P500A	1x 3C TECK90 / AWG 12	Tray	LCP-P35	DF-P500A	Power	
P-SLG-P540A	1x 2C TECK90 / AWG 12	Tray	MCC4B	SLG-P540A	Power	
P-FV-P510A	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P510A	Power	
P-FV-P510B	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P510B	Power	
P-LCP-P36	1x 3C TECK90 / AWG 8	Tray	DP-H32	LCP-P36	Power	
P-FLC-P601A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P601A	Power	
P-FLC-P601A	1x 3C RW90 / AWG 12	Conduit	FLC-P601A	FLC-P601A	Power	
P-FLC-P602A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P602A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-FLC-P602A	1x 3C RW90 / AWG 12	Conduit	FLC-P602A	FLC-P602A	Power	
P-FLC-P603A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P603A	Power	
P-FLC-P603A	1x 3C RW90 / AWG 12	Conduit	FLC-P603A	FLC-P603A	Power	
P-FLC-P604A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P604A	Power	
P-FLC-P604A	1x 3C RW90 / AWG 12	Conduit	FLC-P604A	FLC-P604A	Power	
P-FLC-P605A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P605A	Power	
P-FLC-P605A	1x 3C RW90 / AWG 12	Conduit	FLC-P605A	FLC-P605A	Power	
P-FLC-P606A	1x 3C RW90 / AWG 12	Conduit	LCP-P36	FLC-P606A	Power	
P-FLC-P606A	1x 3C RW90 / AWG 12	Conduit	FLC-P606A	FLC-P606A	Power	
P-DF-P600A	1x 3C TECK90 / AWG 12	Tray	LCP-P36	DF-P600A	Power	
P-SLG-P640A	1x 2C TECK90 / AWG 12	Tray	MCC4B	SLG-P640A	Power	
P-FV-P610A	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P610A	Power	
P-FV-P610B	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P610B	Power	
P-LCP-P37	1x 3C TECK90 / AWG 8	Tray	DP-H32	LCP-P37	Power	
P-FLC-P701A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P701A	Power	
P-FLC-P701A	1x 3C RW90 / AWG 12	Conduit	FLC-P701A	FLC-P701A	Power	
P-FLC-P702A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P702A	Power	
P-FLC-P702A	1x 3C RW90 / AWG 12	Conduit	FLC-P702A	FLC-P702A	Power	
P-FLC-P703A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P703A	Power	
P-FLC-P703A	1x 3C RW90 / AWG 12	Conduit	FLC-P703A	FLC-P703A	Power	
P-FLC-P704A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P704A	Power	
P-FLC-P704A	1x 3C RW90 / AWG 12	Conduit	FLC-P704A	FLC-P704A	Power	
P-FLC-P705A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P705A	Power	
P-FLC-P705A	1x 3C RW90 / AWG 12	Conduit	FLC-P705A	FLC-P705A	Power	
P-FLC-P706A	1x 3C RW90 / AWG 12	Conduit	LCP-P37	FLC-P706A	Power	
P-FLC-P706A	1x 3C RW90 / AWG 12	Conduit	FLC-P706A	FLC-P706A	Power	
P-DF-P700A	1x 3C TECK90 / AWG 12	Tray	LCP-P37	DF-P700A	Power	
P-SLG-P740A	1x 2C TECK90 / AWG 12	Tray	MCC4B	SLG-P740A	Power	
P-FV-P710A	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P710A	Power	
P-FV-P710B	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P710B	Power	
P-LCP-P38	1x 3C TECK90 / AWG 8	Tray	DP-H32	LCP-P38	Power	
P-FLC-P801A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P801A	Power	
P-FLC-P801A	1x 3C RW90 / AWG 12	Conduit	FLC-P801A	FLC-P801A	Power	
P-FLC-P802A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P802A	Power	
P-FLC-P802A	1x 3C RW90 / AWG 12	Conduit	FLC-P802A	FLC-P802A	Power	
P-FLC-P803A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P803A	Power	
P-FLC-P803A	1x 3C RW90 / AWG 12	Conduit	FLC-P803A	FLC-P803A	Power	
P-FLC-P804A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P804A	Power	
P-FLC-P804A	1x 3C RW90 / AWG 12	Conduit	FLC-P804A	FLC-P804A	Power	
P-FLC-P805A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P805A	Power	
P-FLC-P805A	1x 3C RW90 / AWG 12	Conduit	FLC-P805A	FLC-P805A	Power	
P-FLC-P806A	1x 3C RW90 / AWG 12	Conduit	LCP-P38	FLC-P806A	Power	
P-FLC-P806A	1x 3C RW90 / AWG 12	Conduit	FLC-P806A	FLC-P806A	Power	
P-DF-P800A	1x 3C TECK90 / AWG 12	Tray	LCP-P38	DF-P800A	Power	
P-SLG-P840A	1x 2C TECK90 / AWG 12	Tray	MCC4B	SLG-P840A	Power	
P-FV-P810A	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P810A	Power	
P-FV-P810B	1x 2C TECK90 / AWG 12	Tray	TJB-P33.	FV-P810B	Power	
P-LCP-P010A	3x 1C TECK90 / AWG 4/0	Tray	MCC2A	LCP-P010A	Power	
P-P-P010A	1x 3C TECK90 / AWG 4/0	Tray	LCP-P010A	P-P010A	Power	
P-LCP-P020A	3x 1C TECK90 / AWG 4/0	Tray	MCC2A	LCP-P020A	Power	
P-P-P020A	1x 3C TECK90 / AWG 4/0	Tray	LCP-P020A	P-P020A	Power	
P-LCP-P030A	3x 1C TECK90 / AWG 4/0	Tray	MCC2A	LCP-P030A	Power	
P-P-P030A	1x 3C TECK90 / AWG 4/0	Tray	LCP-P030A	P-P030A	Power	
P-FV-P020D	1x 3C TECK90 / AWG 12	Tray	DP-P11	FV-P020D	Power	
P-FV-P020E	1x 3C TECK90 / AWG 12	Tray	DP-P11	FV-P020E	Power	
P-FIT-P001A	2C Multi TECK90 / AWG 14	Tray	CP-P31	FIT-P001A	Power	
P-FIT-P002A	2C Multi TECK90 / AWG 14	Tray	TJB-P33.	FIT-P002A	Power	
P-LCP-P040A	1x 3C TECK90 / AWG 500	Tray	MCC2B	LCP-P040A	Power	
P-P-P040A	1x 3C TECK90 / AWG 500	Tray	LCP-P040A	P-P040A	Power	
P-LCP-P050A	1x 3C TECK90 / AWG 500	Tray	MCC2B	LCP-P050A	Power	
P-P-P050A	1x 3C TECK90 / AWG 500	Tray	LCP-P050A	P-P050A	Power	
P-LCP-P060A	1x 3C TECK90 / AWG 500	Tray	MCC2B	LCP-P060A	Power	
P-P-P060A	1x 3C TECK90 / AWG 500	Tray	LCP-P060A	P-P060A	Power	
P-FV-P050D	1x 3C TECK90 / AWG 12	Tray	DP-P12	FV-P050D	Power	
P-FV-P050E	1x 3C TECK90 / AWG 12	Tray	DP-P12	FV-P050E	Power	
P-FIT-P003A	2C Multi TECK90 / AWG 14	Tray	TJB-P34.	FIT-P003A	Power	
P-FIT-P004A	2C Multi TECK90 / AWG 14	Tray	TJB-P34.	FIT-P004A	Power	
P-LCP-P910A	1x 3C TECK90 / AWG 2	Tray	MCC4A	LCP-P910A	Power	
P-CMP-P910A	1x 3C TECK90 / AWG 2	Tray	LCP-P910A	CMP-P910A	Power	
P-LCP-P920A	1x 3C TECK90 / AWG 2	Tray	MCC4B	LCP-P920A	Power	
P-CMP-P920A	1x 3C TECK90 / AWG 2	Tray	LCP-P920A	CMP-P920A	Power	
P-PIT-P900A	2C Multi TECK90 / AWG 14	Tray	CP-H30.	PIT-P900A	Power	
P-AT-P975A	2C Multi TECK90 / AWG 14	Tray	CP-P31.	AT-P975A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-PT-P930A	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	PT-P930A	Power	
P-PT-P930B	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	PT-P930B	Power	
P-P-P931A	1x 3C TECK90 / AWG 12	Tray	MCC2A	P-P931A	Power	
P-P-P932A	1x 3C TECK90 / AWG 12	Tray	MCC2A	P-P932A	Power	
P-P-P941A	1x 3C TECK90 / AWG 12	Tray	MCC2A	P-P941A	Power	
P-P-P942A	1x 3C TECK90 / AWG 12	Tray	MCC2A	P-P942A	Power	
P-FT-P990A	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	FT-P990A	Power	
P-PT-P950A	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	PT-P950A	Power	
P-PT-P950B	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	PT-P950B	Power	
P-P-P951A	1x 3C TECK90 / AWG 12	Tray	MCC2B	P-P951A	Power	
P-P-P952A	1x 3C TECK90 / AWG 12	Tray	MCC2B	P-P952A	Power	
P-P-P961A	1x 3C TECK90 / AWG 12	Tray	MCC2B	P-P961A	Power	
P-P-P962A	1x 3C TECK90 / AWG 12	Tray	MCC2B	P-P962A	Power	
P-FT-P993A	2C Multi TECK90 / AWG 14	Tray	TJB-O11.	FT-P993A	Power	
P-LCP-P981A	1x 3C TECK90 / AWG 4	Tray	DP-A11	LCP-P981A	Power	
P-P-P981A	1x 3C TECK90 / AWG 8	Tray	LCP-P981A	P-P981A	Power	
P-P-P982A	1x 3C TECK90 / AWG 8	Tray	LCP-P981A	P-P982A	Power	
P-LCP-P983A	1x 3C TECK90 / AWG 12	Tray	DP-A12	LCP-P983A	Power	
P-P-P983A	1x 3C TECK90 / AWG 12	Tray	LCP-P983A	P-P983A	Power	
P-LCP-H110A	1x 3C TECK90 / AWG 300	Tray	MCC1A	LCP-H110A	Power	
P-LCP-H110A	1x 3C TECK90 / AWG 300	Tray	MCC1B	LCP-H110A	Power	
P-P-H110A	1x 3C TECK90 / AWG 300	Tray	LCP-H110A	P-H110A	Power	
P-P-H120A	1x 3C TECK90 / AWG 12	Tray	LCP-H110A	P-H120A	Power	
P-LCP-H130A	1x 3C TECK90 / AWG 1/0	Tray	MCC1A	LCP-H130A	Power	
P-LCP-H130A	1x 3C TECK90 / AWG 1/0	Tray	MCC1B	LCP-H130A	Power	
P-P-H130A	1x 3C TECK90 / AWG 1/0	Tray	LCP-H130A	P-H130A	Power	
P-P-H140A	1x 3C TECK90 / AWG 12	Tray	LCP-H130A	P-H140A	Power	
P-LCP-H500A	1x 3C TECK90 / AWG 12	Tray	MCC1A	LCP-H500A	Power	
P-P-H501A	1x 3C TECK90 / AWG 12	Tray	LCP-H500A	P-H501A	Power	
P-P-H502A	1x 3C TECK90 / AWG 12	Tray	LCP-H500A	P-H502A	Power	
P-LCP-H500A	8C Multi TECK90 / AWG 14	Tray	CP-H10.	LCP-H500A	Power	
P-LCP-H510A	1x 3C TECK90 / AWG 12	Tray	DP-F03	LCP-H510A	Power	
P-P-H511A	1x 3C TECK90 / AWG 12	Tray	LCP-H510A	P-H511A	Power	
P-P-H512A	1x 3C TECK90 / AWG 12	Tray	LCP-H510A	P-H512A	Power	
P-LCP-H510A	8C Multi TECK90 / AWG 14	Tray	CP-H10.	LCP-H510A	Power	
P-LCP-H521A	1x 2C TECK90 / AWG 12	Tray	LP-A11	LCP-H521A	Power	
P-P-H521A	1x 2C TECK90 / AWG 12	Tray	LCP-H521A	P-H521A	Power	
P-LCP-H530A	1x 3C TECK90 / AWG 12	Tray	DP-A12	LCP-H530A	Power	
P-P-H531A	1x 3C TECK90 / AWG 12	Tray	LCP-H530A	P-H531A	Power	
P-P-H532A	1x 3C TECK90 / AWG 12	Tray	LCP-H530A	P-H532A	Power	
P-LCP-H530A	1x 3C TECK90 / AWG 12	Tray	CP-H10.	LCP-H530A	Power	
P-LCP-H701A	1x 3C TECK90 / AWG 8	Tray	DP-A11	LCP-H701A	Power	
P-P-H701A	1x 3C TECK90 / AWG 8	Tray	LCP-H701A	P-H701A	Power	
P-LCP-H700A	1x 3C TECK90 / AWG 4	Tray	DP-A11	LCP-H700A	Power	
P-P-H702A	1x 3C TECK90 / AWG 8	Tray	LCP-H700A	P-H702A	Power	
P-P-H703A	1x 3C TECK90 / AWG 8	Tray	LCP-H700A	P-H703A	Power	
P-LCP-H39	1x 3C TECK90 / AWG 12	Tray	DP-A11	LCP-H39	Power	
P-AHU-H035	1x 3C TECK90 / AWG 12	Tray	DP-H32	AHU-H035	Power	
P-AHU-H061	1x 3C TECK90 / AWG 10	Tray	MCC3A	AHU-H061	Power	
P-AHU-H062	1x 3C TECK90 / AWG 12	Tray	MCC3B	AHU-H062	Power	
P-AHU-H071	1x 3C TECK90 / AWG 12	Tray	MCC3B	AHU-H071	Power	
P-B-H018	1x 2C TECK90 / AWG 12	Tray	LP-R31	B-H018	Power	
P-B-H019	1x 2C TECK90 / AWG 12	Tray	LP-R31	B-H019	Power	
P-EC-H001	1x 2C TECK90 / AWG 12	Tray	LP-F01	EC-H001	Power	
P-EC-H002	1x 2C TECK90 / AWG 12	Tray	LP-F01	EC-H002	Power	
P-EC-H011	1x 2C TECK90 / AWG 12	Tray	LP-R21	EC-H011	Power	
P-EC-H021	1x 2C TECK90 / AWG 12	Tray	LP-H31	EC-H021	Power	
P-EC-H037	1x 2C TECK90 / AWG 12	Tray	LP-C11	EC-H037	Power	
P-EC-H038	1x 2C TECK90 / AWG 12	Tray	LP-C11	EC-H038	Power	
P-EC-H039	1x 2C TECK90 / AWG 12	Tray	LP-C11	EC-H039	Power	
P-EC-H040	1x 2C TECK90 / AWG 12	Tray	LP-C11	EC-H040	Power	
P-EC-H041	1x 2C TECK90 / AWG 12	Tray	LP-H31	EC-H041	Power	
P-EC-H042	1x 2C TECK90 / AWG 12	Tray	LP-H31	EC-H042	Power	
P-EC-H043	1x 2C TECK90 / AWG 12	Tray	LP-H31	EC-H043	Power	
P-EC-H054	1x 2C TECK90 / AWG 12	Tray	LP-A11	EC-H054	Power	
P-EC-H060	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H060	Power	
P-EC-H061	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H061	Power	
P-EC-H062	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H062	Power	
P-EC-H063	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H063	Power	
P-EC-H064	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H064	Power	
P-EC-H065	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H065	Power	
P-EC-H066	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H066	Power	
P-EC-H067	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H067	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-EC-H068	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H068	Power	
P-EC-H069	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H069	Power	
P-EC-H070	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H070	Power	
P-EC-H071	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H071	Power	
P-EC-H072	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H072	Power	
P-EC-H073	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H073	Power	
P-EC-H074	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H074	Power	
P-EC-H075	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H075	Power	
P-EC-H076	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H076	Power	
P-EC-H077	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H077	Power	
P-EC-H078	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H078	Power	
P-EC-H079	1x 2C TECK90 / AWG 12	Tray	LP-A31	EC-H079	Power	
P-EC-H080	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H080	Power	
P-EC-H081	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H081	Power	
P-EC-H082	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H082	Power	
P-EC-H083	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H083	Power	
P-EC-H084	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H084	Power	
P-EC-H085	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H085	Power	
P-EC-H086	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H086	Power	
P-EC-H087	1x 2C TECK90 / AWG 12	Tray	LP-A21	EC-H087	Power	
P-EC-H088	1x 2C TECK90 / AWG 12	Tray	LP-A11	EC-H088	Power	
P-EC-H089	1x 2C TECK90 / AWG 12	Tray	LP-A11	EC-H089	Power	
P-EC-H090	1x 2C TECK90 / AWG 12	Tray	LP-A11	EC-H090	Power	
P-EC-H091	1x 2C TECK90 / AWG 12	Tray	LP-A11	EC-H091	Power	
P-EF-H002	1x 3C TECK90 / AWG 12	Tray	MCC4A	EF-H002	Power	
P-EF-H003	1x 3C TECK90 / AWG 12	Tray	MCC3A	EF-H003	Power	
P-EF-H004	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H004	Power	
P-EF-H005	1x 2C TECK90 / AWG 12	Tray	LP-R21	EF-H005	Power	
P-EF-H006	1x 2C TECK90 / AWG 12	Tray	LP-H31	EF-H006	Power	
P-EF-H013	1x 3C TECK90 / AWG 12	Tray	MCC4A	EF-H013	Power	
P-EF-H014	1x 3C TECK90 / AWG 12	Tray	MCC4A	EF-H014	Power	
P-EF-H015	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H015	Power	
P-EF-H023	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H023	Power	
P-EF-H024	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H024	Power	
P-EF-H025	1x 2C TECK90 / AWG 12	Tray	LP-R31	EF-H025	Power	
P-EF-H037	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H037	Power	
P-EF-H038	1x 3C TECK90 / AWG 12	Tray	MCC3A	EF-H038	Power	
P-EF-H039	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H039	Power	
P-EF-H040	1x 3C TECK90 / AWG 12	Tray	MCC4B	EF-H040	Power	
P-EF-H041	1x 2C TECK90 / AWG 12	Tray	LP-H31	EF-H041	Power	
P-EF-H043	1x 2C TECK90 / AWG 12	Tray	LP-H31	EF-H043	Power	
P-EF-H044	1x 2C TECK90 / AWG 12	Tray	LP-C11	EF-H044	Power	
P-EF-H052	1x 3C TECK90 / AWG 10	Tray	MCC4A	EF-H052	Power	
P-EF-H053	1x 3C TECK90 / AWG 12	Tray	MCC2A	EF-H053	Power	
P-EF-H063	1x 2C TECK90 / AWG 12	Tray	LP-M11	EF-H063	Power	
P-EF-H064	1x 2C TECK90 / AWG 12	Tray	LP-M11	EF-H064	Power	
P-EF-H065	1x 3C TECK90 / AWG 12	Tray	MCC1A	EF-H065	Power	
P-EF-H066	1x 2C TECK90 / AWG 12	Tray	LP-A31	EF-H066	Power	
P-EF-H067	1x 2C TECK90 / AWG 12	Tray	LP-A31	EF-H067	Power	
P-EF-H072	1x 3C TECK90 / AWG 12	Tray	LP-A31	EF-H072	Power	
P-EF-H073	1x 3C TECK90 / AWG 12	Tray	MCC3A	EF-H073	Power	
P-EF-H074	1x 2C TECK90 / AWG 12	Tray	LP-A31	EF-H074	Power	
P-EF-H075	1x 2C TECK90 / AWG 12	Tray	LP-A31	EF-H075	Power	
P-EF-H076	1x 2C TECK90 / AWG 12	Tray	LP-A31	EF-H076	Power	
P-LCP-R31	1x 3C TECK90 / AWG 4	Tray	DP-R31	LCP-R31	Power	
P-ERH-H013A	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H013A	Power	
P-ERH-H013B	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H013B	Power	
P-ERH-H013C	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H013C	Power	
P-ERH-H013D	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H013D	Power	
P-ERH-H014	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H014	Power	
P-ERH-H015A	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H015A	Power	
P-ERH-H015B	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H015B	Power	
P-ERH-H015C	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H015C	Power	
P-ERH-H015D	1x 2C TECK90 / AWG 12	Tray	LCP-R31	ERH-H015D	Power	
P-ERH-H016	1x 2C TECK90 / AWG 12	Tray	LP-R21	ERH-H016	Power	
P-LCP-C31	1x 3C TECK90 / AWG 10	Tray	DP-H31	LCP-C31	Power	
P-ERH-H038A	1x 2C TECK90 / AWG 12	Tray	LCP-C31	ERH-H038A	Power	
P-ERH-H038B	1x 2C TECK90 / AWG 12	Tray	LCP-C31	ERH-H038B	Power	
P-ERH-H039	1x 2C TECK90 / AWG 12	Tray	LCP-C31	ERH-H039	Power	
P-ERH-H040	1x 2C TECK90 / AWG 12	Tray	LCP-C31	ERH-H040	Power	
P-LCP-M31	1x 3C TECK90 / AWG 10	Tray	MCC3B	LCP-M31	Power	
P-ERH-H066A	1x 2C TECK90 / AWG 12	Tray	LCP-M31	ERH-H066A	Power	
P-ERH-H066B	1x 2C TECK90 / AWG 12	Tray	LCP-M31	ERH-H066B	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-ERH-H066C	1x 2C TECK90 / AWG 12	Tray	LCP-M31	ERH-H066C	Power	
P-LCP-A41	1x 3C TECK90 / AWG 12	Tray	MCC3B	LCP-A41	Power	
P-ERH-H071	1x 2C TECK90 / AWG 12	Tray	LCP-A41	ERH-H071	Power	
P-ERH-H072	1x 2C TECK90 / AWG 12	Tray	LCP-A41	ERH-H072	Power	
P-EUH-H031	1x 3C TECK90 / AWG 12	Tray	DP-H31	EUH-H031	Power	
P-EUH-H032	1x 3C TECK90 / AWG 12	Tray	DP-C12	EUH-H032	Power	
P-EUH-H033	1x 3C TECK90 / AWG 12	Tray	DP-C11	EUH-H033	Power	
P-EUH-H034	1x 3C TECK90 / AWG 12	Tray	DP-H31	EUH-H034	Power	
P-EUH-H061	1x 3C TECK90 / AWG 12	Tray	MCC1A	EUH-H061	Power	
P-EUH-H062	1x 3C TECK90 / AWG 12	Tray	MCC1A	EUH-H062	Power	
P-EUH-H063	1x 3C TECK90 / AWG 12	Tray	MCC1A	EUH-H063	Power	
P-EUH-H064	1x 3C TECK90 / AWG 12	Tray	MCC3B	EUH-H064	Power	
P-EUH-H065	1x 3C TECK90 / AWG 12	Tray	MCC1B	EUH-H065	Power	
P-GUH-H001	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H001	Power	
P-GUH-H002	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H002	Power	
P-GUH-H003	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H003	Power	
P-GUH-H011	1x 2C TECK90 / AWG 12	Tray	LP-R31	GUH-H011	Power	
P-GUH-H012	1x 2C TECK90 / AWG 12	Tray	LP-R31	GUH-H012	Power	
P-GUH-H021	1x 2C TECK90 / AWG 12	Tray	LP-R31	GUH-H021	Power	
P-GUH-H022	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H022	Power	
P-GUH-H034	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H034	Power	
P-GUH-H035	1x 2C TECK90 / AWG 12	Tray	LP-H31	GUH-H035	Power	
P-GUH-H036	1x 2C TECK90 / AWG 12	Tray	LP-C11	GUH-H036	Power	
P-GUH-H051	1x 2C TECK90 / AWG 12	Tray	LP-P31	GUH-H051	Power	
P-GUH-H052	1x 2C TECK90 / AWG 12	Tray	LP-P31	GUH-H052	Power	
P-GUH-H053	1x 2C TECK90 / AWG 12	Tray	LP-P31	GUH-H053	Power	
P-GUH-H055	1x 2C TECK90 / AWG 12	Tray	LP-P11	GUH-H055	Power	
P-GUH-H071	1x 2C TECK90 / AWG 12	Tray	LP-A31	GUH-H071	Power	
P-HP-H045	1x 2C TECK90 / AWG 8	Tray	LP-H31	HP-H045	Power	
P-HP-H046	1x 2C TECK90 / AWG 8	Tray	LP-H31	HP-H046	Power	
P-HP-H070	1x 2C TECK90 / AWG 6	Tray	LP-A31	HP-H070	Power	
P-HP-H077	1x 2C TECK90 / AWG 8	Tray	LP-A31	HP-H077	Power	
P-HP-H078	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H078	Power	
P-HP-H079	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H079	Power	
P-HP-H080	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H080	Power	
P-HP-H081	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H081	Power	
P-HP-H082	1x 2C TECK90 / AWG 10	Tray	LP-A31	HP-H082	Power	
P-HP-H083	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H083	Power	
P-HP-H084	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H084	Power	
P-HP-H085	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H085	Power	
P-HP-H086	1x 2C TECK90 / AWG 8	Tray	LP-A31	HP-H086	Power	
P-HP-H087	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H087	Power	
P-HP-H088	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H088	Power	
P-HP-H089	1x 2C TECK90 / AWG 8	Tray	LP-A21	HP-H089	Power	
P-HP-H090	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H090	Power	
P-HP-H091	1x 2C TECK90 / AWG 8	Tray	LP-A21	HP-H091	Power	
P-HP-H092	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H092	Power	
P-HP-H093	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H093	Power	
P-HP-H094	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H094	Power	
P-HP-H095	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H095	Power	
P-HP-H096	1x 2C TECK90 / AWG 8	Tray	LP-A11	HP-H096	Power	
P-HP-H097	1x 2C TECK90 / AWG 8	Tray	LP-A11	HP-H097	Power	
P-HP-H098	1x 2C TECK90 / AWG 12	Tray	LP-A31	HP-H098	Power	
P-HP-H099	1x 2C TECK90 / AWG 12	Tray	LP-A21	HP-H099	Power	
P-HRU-H022	1x 3C TECK90 / AWG 8	Tray	DP-R31	HRU-H022	Power	
P-HRU-H034	1x 3C TECK90 / AWG 12	Tray	DP-H31	HRU-H034	Power	
P-MAU-H001	1x 3C TECK90 / AWG 10	Tray	DP-R31	MAU-H001	Power	
P-MAU-H011	1x 3C TECK90 / AWG 12	Tray	DP-R31	MAU-H011	Power	
P-MAU-H012	1x 3C TECK90 / AWG 10	Tray	DP-R31	MAU-H012	Power	
P-MAU-H021	1x 3C TECK90 / AWG 10	Tray	DP-R31	MAU-H021	Power	
P-MAU-H031	1x 3C TECK90 / AWG 12	Tray	DP-H32	MAU-H031	Power	
P-MAU-H032	1x 3C TECK90 / AWG 12	Tray	DP-H32	MAU-H032	Power	
P-MAU-H033	1x 3C TECK90 / AWG 12	Tray	DP-H32	MAU-H033	Power	
P-MAU-H051	1x 3C TECK90 / AWG 8	Tray	DP-R31	MAU-H051	Power	
P-HWP-H007	1x 3C TECK90 / AWG 12	Tray	MCC1A	HWP-H007	Power	
P-HWP-H008	1x 3C TECK90 / AWG 12	Tray	MCC1B	HWP-H008	Power	
P-HWP-H016	1x 3C TECK90 / AWG 10	Tray	MCC4A	HWP-H016	Power	
P-HWP-H017	1x 3C TECK90 / AWG 10	Tray	MCC4B	HWP-H017	Power	
P-MD-H004A	4C Multi TECK90 / AWG 14	Tray	MCC4B	MD-H004A	Power	
P-MD-H013A	4C Multi TECK90 / AWG 14	Tray	MCC4A	MD-H013A	Power	
P-MD-H014A	4C Multi TECK90 / AWG 14	Tray	MCC4A	MD-H014A	Power	
P-MD-H023A	4C Multi TECK90 / AWG 14	Tray	MCC4B	MD-H023A	Power	
P-MD-H037A	4C Multi TECK90 / AWG 14	Tray	MCC4B	MD-H037A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
P-MD-H038A	4C Multi TECK90 / AWG 14	Tray	MCC3A	MD-H038A	Power	
P-MD-H039A	4C Multi TECK90 / AWG 14	Tray	MCC4B	MD-H039A	Power	
P-MD-H041A	1x 2C TECK90 / AWG 12	Tray	LP-H31	MD-H041A	Power	
P-MD-H043A	1x 2C TECK90 / AWG 12	Tray	LP-H31	MD-H043A	Power	
P-MD-H052A	4C Multi TECK90 / AWG 14	Tray	MCC4A	MD-H052A	Power	
P-MD-H063A	1x 3C TECK90 / AWG 12	Tray	LP-M11	MD-H063A	Power	
P-MD-H063B	1x 3C TECK90 / AWG 12	Tray	LP-M11	MD-H063B	Power	
P-MD-H064A	1x 3C TECK90 / AWG 12	Tray	LP-M11	MD-H064A	Power	
P-MD-H064B	1x 3C TECK90 / AWG 12	Tray	LP-M11	MD-H064B	Power	
P-MD-H065A	4C Multi TECK90 / AWG 14	Tray	MCC1A	MD-H065A	Power	
P-MD-H065B	4C Multi TECK90 / AWG 14	Tray	MCC1A	MD-H065B	Power	
P-MD-H067A	1x 3C TECK90 / AWG 12	Tray	LP-A21	MD-H067A	Power	
P-MD-H072A	1x 3C TECK90 / AWG 12	Tray	LP-A31	MD-H072A	Power	
P-MD-H073A	4C Multi TECK90 / AWG 14	Tray	MCC3A	MD-H073A	Power	
P-MD-H074A	1x 3C TECK90 / AWG 12	Tray	LP-A31	MD-H074A	Power	
P-LCP-R31	1x 2C TECK90 / AWG 8	Tray	LCP-UPS31	LCP-R31	Power	
P-LCP-R32	1x 2C TECK90 / AWG 8	Tray	LCP-UPS31	LCP-R32	Power	
P-CRN-F001	1x 3C TECK90 / AWG 12	Tray	DP-F01	CRN-F001	Power	
P-CRN-F002	1x 3C TECK90 / AWG 12	Tray	DP-F03	CRN-F002	Power	
P-CRN-F003	1x 3C TECK90 / AWG 12	Tray	DP-F01	CRN-F003	Power	
P-CRN-F004	1x 3C TECK90 / AWG 12	Tray	DP-F03	CRN-F004	Power	
P-CRN-F005	1x 3C TECK90 / AWG 12	Tray	DP-F03	CRN-F005	Power	
P-CRN-F006	1x 3C TECK90 / AWG 12	Tray	DP-F03	CRN-F006	Power	
P-CRN-F007	1x 3C TECK90 / AWG 12	Tray	DP-F04	CRN-F007	Power	
P-CRN-F008	1x 3C TECK90 / AWG 12	Tray	DP-F32	CRN-F008	Power	
P-CRN-H001	1x 3C TECK90 / AWG 12	Tray	MCC1B	CRN-H001	Power	
P-CRN-I001	1x 3C TECK90 / AWG 10	Tray	MCC1B	CRN-I001	Power	
P-CRN-I002	1x 3C TECK90 / AWG 10	Tray	MCC1B	CRN-I002	Power	
P-CRN-R001	1x 3C TECK90 / AWG 12	Tray	DP-R22	CRN-R001	Power	
P-CRN-R002	1x 3C TECK90 / AWG 10	Tray	DP-R21	CRN-R002	Power	
P-CRN-R003	1x 3C TECK90 / AWG 12	Tray	DP-R21	CRN-R003	Power	
P-CRN-R004	1x 3C TECK90 / AWG 12	Tray	DP-R22	CRN-R004	Power	
P-CRN-R005	1x 3C TECK90 / AWG 10	Tray	DP-R22	CRN-R005	Power	
P-CRN-M001	1x 3C TECK90 / AWG 10	Tray	DP-C11	CRN-M001	Power	
P-CRN-P001	1x 3C TECK90 / AWG 12	Tray	DP-A11	CRN-P001	Power	
P-CRN-P002	1x 3C TECK90 / AWG 12	Tray	DP-A12	CRN-P002	Power	
P-CRN-P003	1x 3C TECK90 / AWG 12	Tray	DP-A11	CRN-P003	Power	
P-CRN-P004	1x 3C TECK90 / AWG 10	Tray	DP-A11	CRN-P004	Power	
P-CD-I01A	1x 3C TECK90 / AWG 12	Tray	MCC1B	CD-I01A	Power	
P-CD-I01B	1x 3C TECK90 / AWG 12	Tray	MCC1B	CD-I01B	Power	
P-CD-R01A	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-R01A	Power	
P-CD-C01A	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01A	Power	
P-CD-C01B	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01B	Power	
P-CD-C01C	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01C	Power	
P-CD-C01D	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01D	Power	
P-CD-C01E	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01E	Power	
P-CD-C01F	1x 3C TECK90 / AWG 12	Tray	DP-C11	CD-C01F	Power	
P-CD-C01G	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-C01G	Power	
P-CD-C01H	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-C01H	Power	
P-CD-C01I	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-C01I	Power	
P-CD-C01J	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-C01J	Power	
P-CD-P01A	1x 3C TECK90 / AWG 12	Tray	DP-C12	CD-P01A	Power	
P-CD-C02A	1x 3C TECK90 / AWG 12	Tray	DP-F21	CD-C02A	Power	
P-CD-C03A	1x 3C TECK90 / AWG 12	Tray	DP-H31	CD-C03A	Power	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-LT-I000A	4C Multi TECK90 / AWG 14	Tray	JB-I31B	LT-I000A	Control	
C-LT-I000A	1x Pair TECK90 / AWG 16	Tray	JB-I31A	LT-I000A	Control	
C-LS-I000A	2C Multi TECK90 / AWG 14	Tray	JB-I31B	LS-I000A	Control	
C-LS-I000C	2C Multi TECK90 / AWG 14	Tray	JB-I31B	LS-I000C	Control	
C-HV-I001C	4C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I001C	Control	
C-HV-I002C	4C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I002C	Control	
C-SLG-I000C	10C Multi TECK90 / AWG 14	Tray	JB-I31B	SLG-I000C	Control	
C-FV-I000A	7C Multi TECK90 / AWG 14	Tray	JB-I31B	FV-I000A	Control	
C-HV-I005A	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I005A	Control	
C-LT-I000B	4C Multi TECK90 / AWG 14	Tray	JB-I31B	LT-I000B	Control	
C-LT-I000B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	LT-I000B	Control	
C-LS-I000B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	LS-I000B	Control	
C-LS-I000D	2C Multi TECK90 / AWG 14	Tray	JB-I31B	LS-I000D	Control	
C-FV-I000B	7C Multi TECK90 / AWG 14	Tray	JB-I31B	FV-I000B	Control	
C-HV-I003C	4C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I003C	Control	
C-HV-I004C	4C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I004C	Control	
C-HV-I005B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HV-I005B	Control	
C-VT-I001A	1x Pair TECK90 / AWG 16	Tray	LCP-I001A	VT-I001A	Control	
C-TT-I001x	9x Triad TECK90 / AWG 16	Tray	LCP-I001A	TT-I001x	Control	
C-HS-I001A	3C Multi TECK90 / AWG 14	Tray	LCP-I001A	HS-I001A	Control	
C-ZT-I001B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZT-I001B	Control	
C-ZC-I001B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZC-I001B	Control	
C-HS-I001B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HS-I001B	Control	
C-LCP-I001A	6C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-I001A	Control	
C-LCP-I001A	1x CAT5e / AWG 22	Tray	CP-H10	LCP-I001A	Control	
C-ST-I001A	1x Pair TECK90 / AWG 16	Tray	JB-I31B	ST-I001A	Control	
C-VT-I002A	1x Pair TECK90 / AWG 16	Tray	LCP-I002A	VT-I002A	Control	
C-TT-I002x	9x Triad TECK90 / AWG 16	Tray	LCP-I002A	TT-I002x	Control	
C-HS-I002A	3C Multi TECK90 / AWG 14	Tray	LCP-I002A	HS-I002A	Control	
C-ZT-I002B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZT-I002B	Control	
C-ZC-I002B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZC-I002B	Control	
C-HS-I002B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HS-I002B	Control	
C-LCP-I002A	6C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-I002A	Control	
C-LCP-I002A	1x CAT5e / AWG 22	Tray	CP-H10	LCP-I002A	Control	
C-ST-I002A	1x Pair TECK90 / AWG 16	Tray	JB-I31B	ST-I002A	Control	
C-VT-I003A	1x Pair TECK90 / AWG 16	Tray	LCP-I003A	VT-I003A	Control	
C-TT-I003x	9x Triad TECK90 / AWG 16	Tray	LCP-I003A	TT-I003x	Control	
C-HS-I003A	3C Multi TECK90 / AWG 14	Tray	LCP-I003A	HS-I003A	Control	
C-ZT-I003B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZT-I003B	Control	
C-ZC-I003B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZC-I003B	Control	
C-HS-I003B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HS-I003B	Control	
C-LCP-I003A	6C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-I003A	Control	
C-LCP-I003A	1x CAT5e / AWG 22	Tray	CP-H10	LCP-I003A	Control	
C-ST-I003A	1x Pair TECK90 / AWG 16	Tray	JB-I31B	ST-I003A	Control	
C-VT-I004A	1x CAT5e / AWG 22	Tray	LCP-I004A	VT-I004A	Control	
C-TT-I004x	9x Triad TECK90 / AWG 16	Tray	LCP-I004A	TT-I004x	Control	
C-HS-I004A	3C Multi TECK90 / AWG 14	Tray	LCP-I004A	HS-I004A	Control	
C-ZT-I004B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZT-I004B	Control	
C-ZC-I004B	1x Pair TECK90 / AWG 16	Tray	JB-I31A	ZC-I004B	Control	
C-HS-I004B	2C Multi TECK90 / AWG 14	Tray	JB-I31B	HS-I004B	Control	
C-LCP-I004A	-C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-I004A	Control	
C-LCP-I004A	-x Pair TECK90 / AWG 16	Tray	CP-H10	LCP-I004A	Control	
C-ST-I004A	1x Pair TECK90 / AWG 16	Tray	JB-I31B	ST-I004A	Control	
C-FV-F101A	7C Multi RW90 / AWG 14	Conduit	JB0-F31	FV-F101A	Control	
C-FV-F102A	7C Multi RW90 / AWG 14	Conduit	JB0-F31	FV-F102A	Control	
C-LT-F100A	4C Multi RW90 / AWG 14	Conduit	JB0-F31	LT-F100A	Control	
C-LT-F100A	1x Pair Beldon / AWG 16	Conduit	JB0-F31	LT-F100A	Control	
C-FV-F107A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F107A	Control	
C-PT-F100A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F100A	Control	
C-FV-F106A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F106A	Control	
C-FT-F103A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-F103A	Control	
C-FT-F103A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-F103A	Control	
C-FCV-F103A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	FCV-F103A	Control	
C-FCV-F103A	2x Pair TECK90 / AWG 16	Tray	LCP-F01	FCV-F103A	Control	
C-FV-F104A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F104A	Control	
C-FV-F105A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F105A	Control	
C-AT-F110A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F110A	Control	
C-AT-F110A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F110A	Control	
C-FS-F110A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F110A	Control	
C-AT-F110B	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F110B	Control	
C-AT-F110B	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F110B	Control	
C-FS-F110B	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F110B	Control	
C-FV-F201A	7C Multi RW90 / AWG 14	Conduit	JB0-F31	FV-F201A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FV-F202A	7C Multi RW90 / AWG 14	Conduit	JB0-F31	FV-F202A	Control	
C-LT-F200A	4C Multi RW90 / AWG 14	Conduit	JB0-F31	LT-F200A	Control	
C-LT-F200A	1x Pair Beldon / AWG 16	Conduit	JB0-F31	LT-F200A	Control	
C-FV-F207A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F207A	Control	
C-PT-F200A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F200A	Control	
C-FV-F206A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F206A	Control	
C-FT-F203A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-F203A	Control	
C-FT-F203A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-F203A	Control	
C-FCV-F203A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	FCV-F203A	Control	
C-FCV-F203A	2x Pair TECK90 / AWG 16	Tray	LCP-F01	FCV-F203A	Control	
C-FV-F204A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F204A	Control	
C-FV-F205A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F205A	Control	
C-AT-F210A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F210A	Control	
C-AT-F210A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F210A	Control	
C-FS-F210A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F210A	Control	
C-AT-F210B	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F210B	Control	
C-AT-F210B	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F210B	Control	
C-FS-F210B	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F210B	Control	
C-FV-F301A	7C Multi RW90 / AWG 14	Conduit	JB0-F32	FV-F301A	Control	
C-FV-F302A	7C Multi RW90 / AWG 14	Conduit	JB0-F32	FV-F302A	Control	
C-LT-F300A	4C Multi RW90 / AWG 14	Conduit	JB0-F32	LT-F300A	Control	
C-LT-F300A	1x Pair Beldon / AWG 16	Conduit	JB0-F32	LT-F300A	Control	
C-FV-F307A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F307A	Control	
C-PT-F300A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F300A	Control	
C-FV-F306A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F306A	Control	
C-FT-F303A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-F303A	Control	
C-FT-F303A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-F303A	Control	
C-FCV-F303A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	FCV-F303A	Control	
C-FCV-F303A	2x Pair TECK90 / AWG 16	Tray	LCP-F01	FCV-F303A	Control	
C-FV-F304A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F304A	Control	
C-FV-F305A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F305A	Control	
C-AT-F310A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F310A	Control	
C-AT-F310A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F310A	Control	
C-FS-F310A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F310A	Control	
C-AT-F310B	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F310B	Control	
C-AT-F310B	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F310B	Control	
C-FS-F310B	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F310B	Control	
C-FV-F401A	7C Multi RW90 / AWG 14	Conduit	JB0-F32	FV-F401A	Control	
C-FV-F402A	7C Multi RW90 / AWG 14	Conduit	JB0-F32	FV-F402A	Control	
C-LT-F400A	4C Multi RW90 / AWG 14	Conduit	JB0-F32	LT-F400A	Control	
C-LT-F400A	1x Pair Beldon / AWG 16	Conduit	JB0-F32	LT-F400A	Control	
C-FV-F407A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F407A	Control	
C-PT-F400A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F400A	Control	
C-FV-F406A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F406A	Control	
C-FT-F403A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F403A	Control	
C-FT-F403A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F403A	Control	
C-FCV-F403A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	FCV-F403A	Control	
C-FCV-F403A	2x Pair TECK90 / AWG 16	Tray	LCP-F01	FCV-F403A	Control	
C-FV-F404A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F404A	Control	
C-FV-F405A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F405A	Control	
C-AT-F410A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F410A	Control	
C-AT-F410A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F410A	Control	
C-FS-F410A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F410A	Control	
C-AT-F410B	6C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F410B	Control	
C-AT-F410B	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F410B	Control	
C-FS-F410B	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-F410B	Control	
C-FV-F501A	7C Multi RW90 / AWG 14	Conduit	JB0-F33	FV-F501A	Control	
C-FV-F502A	7C Multi RW90 / AWG 14	Conduit	JB0-F33	FV-F502A	Control	
C-LT-F500A	4C Multi RW90 / AWG 14	Conduit	JB0-F33	LT-F500A	Control	
C-LT-F500A	1x Pair Beldon / AWG 16	Conduit	JB0-F33	LT-F500A	Control	
C-FV-F507A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F507A	Control	
C-PT-F500A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F500A	Control	
C-FV-F506A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F506A	Control	
C-FT-F503A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F503A	Control	
C-FT-F503A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F503A	Control	
C-FCV-F503A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	FCV-F503A	Control	
C-FCV-F503A	2x Pair TECK90 / AWG 16	Tray	LCP-F02	FCV-F503A	Control	
C-FV-F504A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F504A	Control	
C-FV-F505A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F505A	Control	
C-AT-F510A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F510A	Control	
C-AT-F510A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F510A	Control	
C-FS-F510A	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F510A	Control	
C-AT-F510B	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F510B	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-AT-F510B	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F510B	Control	
C-FS-F510B	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F510B	Control	
C-FV-F601A	7C Multi RW90 / AWG 14	Conduit	JB0-F33	FV-F601A	Control	
C-FV-F602A	7C Multi RW90 / AWG 14	Conduit	JB0-F33	FV-F602A	Control	
C-LT-F600A	4C Multi RW90 / AWG 14	Conduit	JB0-F33	LT-F600A	Control	
C-LT-F600A	1x Pair Beldon / AWG 16	Conduit	JB0-F33	LT-F600A	Control	
C-FV-F607A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F607A	Control	
C-PT-F600A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F600A	Control	
C-FV-F606A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F606A	Control	
C-FT-F603A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F603A	Control	
C-FT-F603A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F603A	Control	
C-FCV-F603A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	FCV-F603A	Control	
C-FCV-F603A	2x Pair TECK90 / AWG 16	Tray	LCP-F02	FCV-F603A	Control	
C-FV-F604A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F604A	Control	
C-FV-F605A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F605A	Control	
C-AT-F610A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F610A	Control	
C-AT-F610A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F610A	Control	
C-FS-F610A	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F610A	Control	
C-AT-F610B	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F610B	Control	
C-AT-F610B	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F610B	Control	
C-FS-F610B	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F610B	Control	
C-FV-F701A	7C Multi RW90 / AWG 14	Conduit	JB0-F34	FV-F701A	Control	
C-FV-F702A	7C Multi RW90 / AWG 14	Conduit	JB0-F34	FV-F702A	Control	
C-LT-F700A	2C Multi RW90 / AWG 14	Conduit	JB0-F34	LT-F700A	Control	
C-LT-F700A	1x Pair Beldon / AWG 16	Conduit	JB0-F34	LT-F700A	Control	
C-FV-F707A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F707A	Control	
C-PT-F700A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F700A	Control	
C-FV-F706A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F706A	Control	
C-FT-F703A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F703A	Control	
C-FT-F703A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F703A	Control	
C-FCV-F703A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	FCV-F703A	Control	
C-FCV-F703A	2x Pair TECK90 / AWG 16	Tray	LCP-F02	FCV-F703A	Control	
C-FV-F704A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F704A	Control	
C-FV-F705A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F705A	Control	
C-AT-F710A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F710A	Control	
C-AT-F710A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F710A	Control	
C-FS-F710A	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F710A	Control	
C-AT-F710B	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F710B	Control	
C-AT-F710B	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F710B	Control	
C-FS-F710B	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F710B	Control	
C-FV-F801A	7C Multi RW90 / AWG 14	Conduit	JB0-F34	FV-F801A	Control	
C-FV-F802A	7C Multi RW90 / AWG 14	Conduit	JB0-F34	FV-F802A	Control	
C-LT-F800A	4C Multi RW90 / AWG 14	Conduit	JB0-F34	LT-F800A	Control	
C-LT-F800A	1x Pair Beldon / AWG 16	Conduit	JB0-F34	LT-F800A	Control	
C-FV-F807A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F807A	Control	
C-PT-F800A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F800A	Control	
C-FV-F806A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F806A	Control	
C-FT-F803A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F803A	Control	
C-FT-F803A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F803A	Control	
C-FCV-F803A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	FCV-F803A	Control	
C-FCV-F803A	2x Pair TECK90 / AWG 16	Tray	LCP-F02	FCV-F803A	Control	
C-FV-F804A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F804A	Control	
C-FV-F805A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F805A	Control	
C-AT-F810A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F810A	Control	
C-AT-F810A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F810A	Control	
C-FS-F810A	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F810A	Control	
C-AT-F810B	6C Multi TECK90 / AWG 14	Tray	LCP-F02	AT-F810B	Control	
C-AT-F810B	1x Pair TECK90 / AWG 16	Tray	LCP-F02	AT-F810B	Control	
C-FS-F810B	2C Multi TECK90 / AWG 14	Tray	LCP-F02	FS-F810B	Control	
C-FV-J991A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-J991A	Control	
C-PT-F910A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F910A	Control	
C-FV-F912A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F912A	Control	
C-FV-F910A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F910A	Control	
C-FCV-F911A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	FCV-F911A	Control	
C-FCV-F911A	2x Pair TECK90 / AWG 16	Tray	LCP-F01	FCV-F911A	Control	
C-TT-F911A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	TT-F911A	Control	
C-PS-F911A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	PS-F911A	Control	
C-PT-F911A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	PT-F911A	Control	
C-FT-F911A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-F911A	Control	
C-FT-F911A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-F911A	Control	
C-FV-F931A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F931A	Control	
C-HS-F931A	5C Multi TECK90 / AWG 14	Tray	FV-F931A	HS-F931A	Control	
C-PT-F920A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F920A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FV-F922A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F922A	Control	
C-FV-F920A	7C Multi TECK90 / AWG 14	Tray	LCP-F02	FV-F920A	Control	
C-FV-F932A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F932A	Control	
C-FCV-F921A	6C Multi TECK90 / AWG 14	Tray	LCP-F02	FCV-F921A	Control	
C-FCV-F921A	2x Pair TECK90 / AWG 16	Tray	LCP-F02	FCV-F921A	Control	
C-TT-F921A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	TT-F921A	Control	
C-PT-F921A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	PT-F921A	Control	
C-FT-F921A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	FT-F921A	Control	
C-FT-F921A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	FT-F921A	Control	
C-FV-F933A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F933A	Control	
C-FV-J992A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-J992A	Control	
C-PT-F010A	1x Pair TECK90 / AWG 16	Tray	CP-H30	PT-F010A	Control	
C-VS-F010A	2C Multi TECK90 / AWG 14	Tray	MCC4A	VS-F010A	Control	
C-IS-F010A	2C Multi TECK90 / AWG 14	Tray	MCC4A	IS-F010A	Control	
C-HS-F010A	3C Multi TECK90 / AWG 14	Tray	LCP-F010B	HS-F010A	Control	
C-LCP-F010B	8C Multi TECK90 / AWG 14	Tray	CP-H30	LCP-F010B	Control	
C-LCP-F010B	1x Pair TECK90 / AWG 16	Tray	CP-H30	LCP-F010B	Control	
C-TT-F010x	8x Triad TECK90 / AWG 16	Tray	MCC4A	TT-F010x	Control	
C-MCC4A	1x CAT5e / AWG 22	Tray	CP-H30	MCC4A	Control	
C-PT-F010B	1x Pair TECK90 / AWG 16	Tray	CP-H30	PT-F010B	Control	
C-FV-F010A	7C Multi TECK90 / AWG 14	Tray	CP-H30	FV-F010A	Control	
C-PT-F020A	1x Pair TECK90 / AWG 16	Tray	CP-H30	PT-F020A	Control	
C-VS-F020A	2C Multi TECK90 / AWG 14	Tray	MCC4B	VS-F020A	Control	
C-IS-F020A	2C Multi TECK90 / AWG 14	Tray	MCC4B	IS-F020A	Control	
C-HS-F020A	3C Multi TECK90 / AWG 14	Tray	LCP-F020B	HS-F020A	Control	
C-LCP-F020B	8C Multi TECK90 / AWG 14	Tray	CP-H30	LCP-F020B	Control	
C-LCP-F020B	1x Pair TECK90 / AWG 16	Tray	CP-H30	LCP-F020B	Control	
C-TT-F020x	8x Triad TECK90 / AWG 16	Tray	MCC4B	TT-F020x	Control	
C-MCC4B	1x CAT5e / AWG 22	Tray	CP-H30	MCC4B	Control	
C-PT-F020B	1x Pair TECK90 / AWG 16	Tray	CP-H30	PT-F020B	Control	
C-FV-F020A	7C Multi TECK90 / AWG 14	Tray	CP-H30	FV-F020A	Control	
C-TT-F030A	1x Pair TECK90 / AWG 16	Tray	CP-H30	TT-F030A	Control	
C-FT-F030A	2C Multi TECK90 / AWG 14	Tray	CP-H30	FT-F030A	Control	
C-FT-F030A	1x Pair TECK90 / AWG 16	Tray	CP-H30	FT-F030A	Control	
C-FV-F052A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F052A	Control	
C-FV-F051A	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-F051A	Control	
C-LT-F050A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-F050A	Control	
C-LT-F050A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-F050A	Control	
C-SLG-F053A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-F053A	Control	
C-SLG-F054A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-F054A	Control	
C-SLG-F055A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-F055A	Control	
C-FS-F056A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FS-F056A	Control	
C-AT-F056A	3C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-F056A	Control	
C-AT-F056A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-F056A	Control	
C-LCP-J702A	8C Multi TECK90 / AWG 14	Tray	LCP-F01	LCP-J702A	Control	
C-PS-J702A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	PS-J702A	Control	
C-FV-J702C	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-J702C	Control	
C-FV-J703C	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-J703C	Control	
C-LCP-J701A	8C Multi TECK90 / AWG 14	Tray	LCP-F01	LCP-J701A	Control	
C-PS-J701A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	PS-J701A	Control	
C-FV-J701C	7C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-J701C	Control	
C-FT-J701A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-J701A	Control	
C-FT-J701A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-J701A	Control	
C-FV-C110B	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-C110B	Control	
C-FT-J702A	4C Multi TECK90 / AWG 14	Tray	LCP-F01	FT-J702A	Control	
C-FT-J702A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	FT-J702A	Control	
C-FV-C110A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FV-C110A	Control	
C-LCP-F055A	10C Multi TECK90 / AWG 14	Tray	LCP-F01	LCP-F055A	Control	
C-FS-F055A	2C Multi TECK90 / AWG 14	Tray	LCP-F055A	FS-F055A	Control	
C-LT-F980A	4C Multi TECK90 / AWG 14	Tray	LCP-F02	LT-F980A	Control	
C-LT-F980A	1x Pair TECK90 / AWG 16	Tray	LCP-F02	LT-F980A	Control	
C-LT-F980B	4C Multi TECK90 / AWG 14	Tray	LCP-F02	LT-F980B	Control	
C-LT-F980B	1x Pair TECK90 / AWG 16	Tray	LCP-F02	LT-F980B	Control	
C-LY-F980B	2C Multi TECK90 / AWG 14	Tray	LCP-F981A	LY-F980B	Control	
C-LY-F980B	2C Multi TECK90 / AWG 14	Tray	LCP-F983A	LY-F980B	Control	
C-AE-F981A	2C Multi TECK90 / AWG 14	Tray	LCP-F981A	AE-F981A	Control	
C-AE-F982A	2C Multi TECK90 / AWG 14	Tray	LCP-F981A	AE-F982A	Control	
C-LCP-F981A	16C Multi TECK90 / AWG 14	Tray	LCP-F02	LCP-F981A	Control	
C-AE-F983A	2C Multi TECK90 / AWG 14	Tray	LCP-F983A	AE-F983A	Control	
C-LCP-F983A	8C Multi TECK90 / AWG 14	Tray	LCP-F02	LCP-F983A	Control	
C-AE-F984A	2C Multi TECK90 / AWG 14	Tray	LCP-F984A	AE-F984A	Control	
C-LCP-F984A	12C Multi TECK90 / AWG 14	Tray	LCP-F02	LCP-F984A	Control	
C-LS-F984A	2C Multi TECK90 / AWG 14	Tray	LCP-F02	LS-F984A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-LS-F984B	2C Multi TECK90 / AWG 14	Tray	LCP-F02	LS-F984B	Control	
C-PS-F911A	2C Multi TECK90 / AWG 14	Tray	LCP-F911A	PS-F911A	Control	
C-HS-F911A	3C Multi TECK90 / AWG 14	Tray	LCP-F911A	HS-F911A	Control	
C-TE-F911x	6x Pair TECK90 / AWG 16	Tray	LCP-F911A	TE-F911x	Control	
C-LCP-F911A	8C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-F911A	Control	
C-LCP-F911A	3x Pair TECK90 / AWG 16	Tray	CP-H10	LCP-F911A	Control	
C-PS-F921A	2C Multi TECK90 / AWG 14	Tray	LCP-F921A	PS-F921A	Control	
C-HS-F921A	3C Multi TECK90 / AWG 14	Tray	LCP-F921A	HS-F921A	Control	
C-TE-F921A	6x Pair TECK90 / AWG 16	Tray	LCP-F921A	TE-F921A	Control	
C-LCP-F921A	8C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-F921A	Control	
C-LCP-F921A	3x Pair TECK90 / AWG 16	Tray	CP-H10	LCP-F921A	Control	
C-YS-C800A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	YS-C800A	Control	
C-LA-C800A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	LA-C800A	Control	
C-LA-C800B	2C Multi TECK90 / AWG 14	Tray	TJB-C12	LA-C800B	Control	
C-FV-C810B	7C Multi TECK90 / AWG 14	Tray	LCP-C800A	FV-C810B	Control	
C-FV-C810B	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C810B	Control	
C-FV-C810B	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C810B	Control	
C-FV-C810B	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C810B	Control	
C-LT-C810A	4C Multi TECK90 / AWG 14	Tray	TJB-C12	LT-C810A	Control	
C-LT-C810A	1x Pair TECK90 / AWG 16	Tray	TJB-C12	LT-C810A	Control	
C-LT-C810A	4C Multi TECK90 / AWG 14	Tray	LCP-C800A	LT-C810A	Control	
C-LT-C810A	1x Pair TECK90 / AWG 16	Tray	LCP-C800A	LT-C810A	Control	
C-LE-C810A	1x Pair TECK90 / AWG 16	Tray	LT-C810A	LE-C810A	Control	
C-FV-C820B	7C Multi TECK90 / AWG 14	Tray	LCP-C800A	FV-C820B	Control	
C-FV-C820B	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C820B	Control	
C-LT-C820A	4C Multi TECK90 / AWG 14	Tray	TJB-C12	LT-C820A	Control	
C-LT-C820A	1x Pair TECK90 / AWG 16	Tray	TJB-C12	LT-C820A	Control	
C-LT-C820A	4C Multi TECK90 / AWG 14	Tray	LCP-C800A	LT-C820A	Control	
C-LT-C820A	1x Pair TECK90 / AWG 16	Tray	LCP-C800A	LT-C820A	Control	
C-LE-C820A	1x Pair TECK90 / AWG 16	Tray	LT-C820A	LE-C820A	Control	
C-LS-C800A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	LS-C800A	Control	
C-LCP-C840A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C840A	Control	
C-FV-C840A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C840A	Control	
C-FS-C840A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	FS-C840A	Control	
C-FT-C840A	1x Pair TECK90 / AWG 16	Tray	TJB-C12	FT-C840A	Control	
C-LCP-C850A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C850A	Control	
C-FV-C850A	10C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C850A	Control	
C-FS-C850A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	FS-C850A	Control	
C-FT-C850A	1x Pair TECK90 / AWG 16	Tray	TJB-C12	FT-C850A	Control	
C-LCP-C860A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C860A	Control	
C-FV-C860A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C860A	Control	
C-FS-C860A	2C Multi TECK90 / AWG 14	Tray	TJB-C12	FS-C860A	Control	
C-FT-C860A	1x Pair TECK90 / AWG 16	Tray	TJB-C12	FT-C860A	Control	
C-FV-C860C	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C860C	Control	
C-FV-C860D	7C Multi TECK90 / AWG 14	Tray	TJB-C12	FV-C860D	Control	
C-LE-C940B	1x Pair TECK90 / AWG 16	Tray	LT-C940B	LE-C940B	Control	
C-LT-C940B	1x Pair TECK90 / AWG 16	Tray	TJB-C11	LT-C940B	Control	
C-LS-C980A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	LS-C980A	Control	
C-LCP-C950A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C950A	Control	
C-FT-C950A	1x Pair TECK90 / AWG 16	Tray	TJB-C11	FT-C950A	Control	
C-FV-C950A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	FV-C950A	Control	
C-FS-C950A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	FS-C950A	Control	
C-LCP-C960A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C960A	Control	
C-FT-C960A	1x Pair TECK90 / AWG 16	Tray	TJB-C11	FT-C960A	Control	
C-FV-C960A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	FV-C960A	Control	
C-FS-C960A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	FS-C960A	Control	
C-LCP-C970A	1x CAT5e / AWG 22	Tray	CP-H30	LCP-C970A	Control	
C-FT-C970A	1x Pair TECK90 / AWG 16	Tray	TJB-C11	FT-C970A	Control	
C-FV-C970A	7C Multi TECK90 / AWG 14	Tray	TJB-C11	FV-C970A	Control	
C-FS-C970A	2C Multi TECK90 / AWG 14	Tray	TJB-C11	FS-C970A	Control	
C-FV-C970D	7C Multi TECK90 / AWG 14	Tray	TJB-C11	FV-C970D	Control	
C-FV-C970C	7C Multi TECK90 / AWG 14	Tray	TJB-C11	FV-C970C	Control	
C-HS-C020A	3C Multi TECK90 / AWG 14	Tray	PCU-C020	HS-C020A	Control	
C-PCU-C020	8C Multi TECK90 / AWG 14	Tray	CP-C11	PCU-C020	Control	
C-LS-C020A	2C Multi TECK90 / AWG 14	Tray	CP-C11	LS-C020A	Control	
C-LS-C020B	2C Multi TECK90 / AWG 14	Tray	CP-C11	LS-C020B	Control	
C-WT-C020A	4C Multi TECK90 / AWG 14	Tray	CP-C11	WT-C020A	Control	
C-WT-C020A	1x Pair TECK90 / AWG 16	Tray	CP-C11	WT-C020A	Control	
C-HS-C020B	3C Multi TECK90 / AWG 14	Tray	PCU-C020	HS-C020B	Control	
C-CFR-C020B	4C Multi TECK90 / AWG 14	Tray	CP-C11	CFR-C020B	Control	
C-HS-C030A	3C Multi TECK90 / AWG 14	Tray	PCU-C030	HS-C030A	Control	
C-PCU-C030	8C Multi TECK90 / AWG 14	Tray	CP-C11	PCU-C030	Control	
C-LS-C030A	2C Multi TECK90 / AWG 14	Tray	CP-C11	LS-C030A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-LS-C030B	2C Multi TECK90 / AWG 14	Tray	CP-C11	LS-C030B	Control	
C-WT-C030A	4C Multi TECK90 / AWG 14	Tray	CP-C11	WT-C030A	Control	
C-WT-C030A	1x Pair TECK90 / AWG 16	Tray	CP-C11	WT-C030A	Control	
C-HS-C030B	3C Multi TECK90 / AWG 14	Tray	PCU-C030	HS-C030B	Control	
C-PCU-C030	8C Multi TECK90 / AWG 14	Tray	CP-C11	PCU-C030	Control	
C-TS-C020A	8C Multi TECK90 / AWG 14	Tray	TJB-A11	TS-C020A	Control	
C-HS-C021B	3C Multi TECK90 / AWG 14	Tray	PPU-C021	HS-C021B	Control	
C-PPU-C021	15C Multi TECK90 / AWG 14	Tray	CP-C11	PPU-C021	Control	
C-SOL-C021B	2C Multi TECK90 / AWG 14	Tray	PPU-C021	SOL-C021B	Control	
C-LS-C021A	4C Multi TECK90 / AWG 14	Tray	PPU-C021	LS-C021A	Control	
C-FV-C021A	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C021A	Control	
C-HS-C031B	3C Multi TECK90 / AWG 14	Tray	PPU-C031	HS-C031B	Control	
C-LCP-C031	15C Multi TECK90 / AWG 14	Tray	CP-C11	LCP-C031	Control	
C-SOL-C031B	2C Multi TECK90 / AWG 14	Tray	PPU-C031	SOL-C031B	Control	
C-LS-C031A	4C Multi TECK90 / AWG 14	Tray	PPU-C031	LS-C031A	Control	
C-FV-C031A	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C031A	Control	
C-HS-C001A	3C Multi TECK90 / AWG 14	Tray	LCP-C001	HS-C001A	Control	
C-PPU-C001	8C Multi TECK90 / AWG 14	Tray	CP-C11	PPU-C001	Control	
C-FT-C001B	4C Multi TECK90 / AWG 14	Tray	LCP-C001	FT-C001B	Control	
C-FT-C001B	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C001B	Control	
C-WT-C001B	2C Multi TECK90 / AWG 14	Tray	CP-C11	WT-C001B	Control	
C-WT-C001B	1x Pair TECK90 / AWG 16	Tray	CP-C11	WT-C001B	Control	
C-LS-C005A	2C Multi TECK90 / AWG 14	Tray	CP-C11	LS-C005A	Control	
C-LT-C022A	4C Multi TECK90 / AWG 14	Tray	CP-C11	LT-C022A	Control	
C-LE-C022A	1x Pair TECK90 / AWG 16	Tray	LT-C022A	LE-C022A	Control	
C-LT-C022A	1x Pair TECK90 / AWG 16	Tray	CP-C11	LT-C022A	Control	
C-LT-C032A	4C Multi TECK90 / AWG 14	Tray	CP-C11	LT-C032A	Control	
C-LE-C032A	1x Pair TECK90 / AWG 16	Tray	LT-C032A	LE-C032A	Control	
C-LT-C032A	1x Pair TECK90 / AWG 16	Tray	CP-C11	LT-C032A	Control	
C-LCP-C061A	1x CAT5e / AWG 22	Tray	CP-C11	LCP-C061A	Control	
C-TS-C061A	2C Multi TECK90 / AWG 14	Tray	CP-C11	TS-C061A	Control	
C-PS-C061A	2C Multi TECK90 / AWG 14	Tray	CP-C11	PS-C061A	Control	
C-FT-C061A	4C Multi TECK90 / AWG 14	Tray	CP-C11	FT-C061A	Control	
C-FT-C061A	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C061A	Control	
C-FV-C061A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C061A	Control	
C-FS-C061A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FS-C061A	Control	
C-LCP-C062A	1x CAT5e / AWG 22	Tray	CP-C11	LCP-C062A	Control	
C-TS-C062A	2C Multi TECK90 / AWG 14	Tray	CP-C11	TS-C062A	Control	
C-PS-C062A	2C Multi TECK90 / AWG 14	Tray	CP-C11	PS-C062A	Control	
C-FT-C062A	4C Multi TECK90 / AWG 14	Tray	CP-C11	FT-C062A	Control	
C-FT-C062A	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C062A	Control	
C-FV-C062A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C062A	Control	
C-FS-C062A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FS-C062A	Control	
C-LCP-C063A	1x CAT5e / AWG 22	Tray	CP-C11	LCP-C063A	Control	
C-TS-C063A	2C Multi TECK90 / AWG 14	Tray	CP-C11	TS-C063A	Control	
C-PS-C063A	2C Multi TECK90 / AWG 14	Tray	CP-C11	PS-C063A	Control	
C-FT-C063A	4C Multi TECK90 / AWG 14	Tray	CP-C11	FT-C063A	Control	
C-FT-C063A	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C063A	Control	
C-FV-C063A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C063A	Control	
C-FS-C063A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FS-C063A	Control	
C-FV-C064B	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C064B	Control	
C-FV-C065B	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C065B	Control	
C-LCP-C071A	1x CAT5e / AWG 22	Tray	CP-C11	LCP-C071A	Control	
C-TS-C071A	2C Multi TECK90 / AWG 14	Tray	LCP-C071A	TS-C071A	Control	
C-FT-C071A	4C Multi TECK90 / AWG 14	Tray	CP-C11	FT-C071A	Control	
C-FT-C071A	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C071A	Control	
C-FV-C071A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C071A	Control	
C-FS-C071A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FS-C071A	Control	
C-FV-C073A	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C073A	Control	
C-P-C072A	1x CAT5e / AWG 22	Tray	CP-C11	P-C072A	Control	
C-TS-C072A	2C Multi TECK90 / AWG 14	Tray	CP-C11	TS-C072A	Control	
C-FT-C072A	4C Multi TECK90 / AWG 14	Tray	CP-C11	FT-C072A	Control	
C-FT-C072A	1x Pair TECK90 / AWG 16	Tray	CP-C11	FT-C072A	Control	
C-FV-C072A	7C Multi TECK90 / AWG 14	Tray	CP-C11	FV-C072A	Control	
C-FS-C072A	2C Multi TECK90 / AWG 14	Tray	CP-C11	FS-C072A	Control	
C-HS-O210A	3C Multi TECK90 / AWG 14	Tray	TJB-F31	HS-O210A	Control	
C-HS-O230A	3C Multi TECK90 / AWG 14	Tray	TJB-F32	HS-O230A	Control	
C-PT-O010A	1x Pair TECK90 / AWG 16	Tray	PV-O010A	PT-O010A	Control	
C-LT-O010A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	LT-O010A	Control	
C-LT-O010A	1x Pair TECK90 / AWG 16	Tray	PV-O010A	LT-O010A	Control	
C-PS-O010A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	PS-O010A	Control	
C-LS-O010A	2C Multi TECK90 / AWG 14	Tray	PV-O010A	LS-O010A	Control	
C-FV-O010A	10C Multi TECK90 / AWG 14	Tray	PV-O010A	FV-O010A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FV-O021A	10C Multi TECK90 / AWG 14	Tray	PV-O010A	FV-O021A	Control	
C-FV-O011A	10C Multi TECK90 / AWG 14	Tray	PV-O010A	FV-O011A	Control	
C-TT-O012A	1x Pair TECK90 / AWG 16	Tray	PV-O010A	TT-O012A	Control	
C-PT-O015A	1x Pair TECK90 / AWG 16	Tray	PV-O010A	PT-O015A	Control	
C-FV-O015A	10C Multi TECK90 / AWG 14	Tray	PV-O010A	FV-O015A	Control	
C-PT-O020A	1x Pair TECK90 / AWG 16	Tray	LCP-O020A	PT-O020A	Control	
C-LT-O020A	2C Multi TECK90 / AWG 14	Tray	LCP-O020A	LT-O020A	Control	
C-LT-O020A	1x Pair TECK90 / AWG 16	Tray	LCP-O020A	LT-O020A	Control	
C-PS-O020A	2C Multi TECK90 / AWG 14	Tray	LCP-O020A	PS-O020A	Control	
C-LS-O020A	2C Multi TECK90 / AWG 14	Tray	LCP-O020A	LS-O020A	Control	
C-FV-O020A	10C Multi TECK90 / AWG 14	Tray	LCP-O020A	FV-O020A	Control	
C-PT-O030A	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O030A	Control	
C-PT-O031A	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O031A	Control	
C-AT-O032A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O032A	Control	
C-CMP-O052A	2C Multi TECK90 / AWG 14	Tray	LCP-O050	CMP-O052A	Control	
C-CMP-O053A	2C Multi TECK90 / AWG 14	Tray	LCP-O050	CMP-O053A	Control	
C-FS-O051A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FS-O051A	Control	
C-AT-O051A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O051A	Control	
C-FV-O119A	10C Multi TECK90 / AWG 14	Tray	PSU-O310A	FV-O119A	Control	
C-PT-O110A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	PT-O110A	Control	
C-TT-O110A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O110A	Control	
C-FM-O115A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	FM-O115A	Control	
C-LS-O110A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	LS-O110A	Control	
C-LS-O110B	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	LS-O110B	Control	
C-PT-O112A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	PT-O112A	Control	
C-TT-O112A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O112A	Control	
C-FT-O112A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	FT-O112A	Control	
C-FCV-O112A	6C Multi TECK90 / AWG 14	Tray	PSU-O310A	FCV-O112A	Control	
C-FCV-O112A	2x Pair TECK90 / AWG 16	Tray	PSU-O310A	FCV-O112A	Control	
C-AT-O112A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	AT-O112A	Control	
C-AT-O112A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	AT-O112A	Control	
C-FV-O112B	10C Multi TECK90 / AWG 14	Tray	PSU-O310A	FV-O112B	Control	
C-AT-O110A	2C Multi TECK90 / AWG 14	Tray	CP-O30	AT-O110A	Control	
C-AT-O110A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O110A	Control	
C-AT-O110B	2C Multi TECK90 / AWG 14	Tray	CP-O30	AT-O110B	Control	
C-AT-O110B	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O110B	Control	
C-FV-O139A	10C Multi TECK90 / AWG 14	Tray	PSU-O320A	FV-O139A	Control	
C-PT-O130A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	PT-O130A	Control	
C-TT-O130A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O130A	Control	
C-LS-O130A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	LS-O130A	Control	
C-LS-O130B	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	LS-O130B	Control	
C-PT-O132A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	PT-O132A	Control	
C-TT-O132A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O132A	Control	
C-FT-O132A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	FT-O132A	Control	
C-FCV-O132A	6C Multi TECK90 / AWG 14	Tray	PSU-O320A	FCV-O132A	Control	
C-FCV-O132A	2x Pair TECK90 / AWG 16	Tray	PSU-O320A	FCV-O132A	Control	
C-AT-O132A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	AT-O132A	Control	
C-AT-O132A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	AT-O132A	Control	
C-FV-O132B	10C Multi TECK90 / AWG 14	Tray	PSU-O320A	FV-O132B	Control	
C-AT-O130A	2C Multi TECK90 / AWG 14	Tray	CP-O30	AT-O130A	Control	
C-AT-O130A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O130A	Control	
C-AT-O130B	2C Multi TECK90 / AWG 14	Tray	CP-O30	AT-O130B	Control	
C-AT-O130B	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O130B	Control	
C-FV-O159A	10C Multi TECK90 / AWG 14	Tray	PSU-O330A	FV-O159A	Control	
C-PT-O150A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	PT-O150A	Control	
C-TT-O150A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O150A	Control	
C-FM-O155A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	FM-O155A	Control	
C-LS-O150A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	LS-O150A	Control	
C-LS-O150B	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	LS-O150B	Control	
C-PT-O152A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	PT-O152A	Control	
C-TT-O152A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O152A	Control	
C-FT-O152A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	FT-O152A	Control	
C-FCV-O152A	6C Multi TECK90 / AWG 14	Tray	PSU-O330A	FCV-O152A	Control	
C-FCV-O152A	2x Pair TECK90 / AWG 16	Tray	PSU-O330A	FCV-O152A	Control	
C-AT-O152A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	AT-O152A	Control	
C-AT-O152A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	AT-O152A	Control	
C-FV-O152A	10C Multi TECK90 / AWG 14	Tray	PSU-O330A	FV-O152A	Control	
C-AT-O150A	2C Multi TECK90 / AWG 14	Tray	CP-O30	AT-O150A	Control	
C-AT-O150A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O150A	Control	
C-FV-O201A	10C Multi TECK90 / AWG 14	Tray	CP-O30	FV-O201A	Control	
C-FV-O202A	10C Multi TECK90 / AWG 14	Tray	CP-O30	FV-O202A	Control	
C-FT-O216A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O216A	Control	
C-FT-O216A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O216A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FCV-O216A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O216A	Control	
C-FCV-O216A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O216A	Control	
C-FT-O217A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O217A	Control	
C-FT-O217A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O217A	Control	
C-FCV-O217A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O217A	Control	
C-FCV-O217A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O217A	Control	
C-FT-O218A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O218A	Control	
C-FT-O218A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O218A	Control	
C-FCV-O218A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O218A	Control	
C-FCV-O218A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O218A	Control	
C-FT-O236A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O236A	Control	
C-FT-O236A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O236A	Control	
C-FCV-O236A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O236A	Control	
C-FCV-O236A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O236A	Control	
C-FT-O237A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O237A	Control	
C-FT-O237A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O237A	Control	
C-FCV-O237A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O237A	Control	
C-FCV-O237A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O237A	Control	
C-FT-O238A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FT-O238A	Control	
C-FT-O238A	1x Pair TECK90 / AWG 16	Tray	CP-O30	FT-O238A	Control	
C-FCV-O238A	6C Multi TECK90 / AWG 14	Tray	CP-O30	FCV-O238A	Control	
C-FCV-O238A	2x Pair TECK90 / AWG 16	Tray	CP-O30	FCV-O238A	Control	
C-HS-O210A	7C Multi TECK90 / AWG 14	Tray	SLG-O210A	HS-O210A	Control	
C-SLG-O210A	10C Multi TECK90 / AWG 14	Tray	TJB-P33	SLG-O210A	Control	
C-HS-O210B	7C Multi TECK90 / AWG 14	Tray	SLG-O210B	HS-O210B	Control	
C-SLG-O210B	10C Multi TECK90 / AWG 14	Tray	TJB-F31	SLG-O210B	Control	
C-HS-O210C	7C Multi TECK90 / AWG 14	Tray	SLG-O210C	HS-O210C	Control	
C-SLG-O210C	10C Multi TECK90 / AWG 14	Tray	TJB-F31	SLG-O210C	Control	
C-HS-C701A	3C Multi TECK90 / AWG 14	Tray	MXR-C701A	HS-C701A	Control	
C-MCC4A	8C Multi TECK90 / AWG 14	Tray	CP-H30	MCC4A	Control	
C-LT-C701A	2C Multi TECK90 / AWG 14	Tray	TJB-F31	LT-C701A	Control	
C-LT-C701A	1x Pair TECK90 / AWG 16	Tray	TJB-F31	LT-C701A	Control	
C-HS-O230A	7C Multi TECK90 / AWG 14	Tray	SLG-O230A	HS-O230A	Control	
C-SLG-O230A	10C Multi TECK90 / AWG 14	Tray	TJB-F32	SLG-O230A	Control	
C-HS-O230A	7C Multi TECK90 / AWG 14	Tray	SLG-O230B	HS-O230A	Control	
C-SLG-O230B	10C Multi TECK90 / AWG 14	Tray	TJB-F32	SLG-O230B	Control	
C-HS-O230C	7C Multi TECK90 / AWG 14	Tray	SLG-O230C	HS-O230C	Control	
C-SLG-O230C	10C Multi TECK90 / AWG 14	Tray	TJB-F32	SLG-O230C	Control	
C-HS-C702A	7C Multi TECK90 / AWG 14	Tray	MXR-C702A	HS-C702A	Control	
C-MXR-C702A	8C Multi TECK90 / AWG 14	Tray	CP-H30	MXR-C702A	Control	
C-LT-C702A	2C Multi TECK90 / AWG 14	Tray	TJB-F32	LT-C702A	Control	
C-LT-C702A	1x Pair TECK90 / AWG 16	Tray	TJB-F32	LT-C702A	Control	
C-PT-O501A	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O501A	Control	
C-PT-O501B	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O501B	Control	
C-AT-O501A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O501A	Control	
C-FV-O521A	10C Multi TECK90 / AWG 14	Tray	CP-O30	FV-O521A	Control	
C-FCV-O510A	6C Multi TECK90 / AWG 14	Tray	LCP-O510A	FCV-O510A	Control	
C-FCV-O510A	2x Pair TECK90 / AWG 16	Tray	LCP-O510A	FCV-O510A	Control	
C-TT-O510A	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	TT-O510A	Control	
C-HTR-O510A	4C Multi TECK90 / AWG 14	Tray	LCP-O510A	HTR-O510A	Control	
C-TT-O510B	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	TT-O510B	Control	
C-CDU-O510A	4C Multi TECK90 / AWG 14	Tray	LCP-O510A	CDU-O510A	Control	
C-PT-O510A	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	PT-O510A	Control	
C-TT-O510C	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	TT-O510C	Control	
C-BLW-O510A	4C Multi TECK90 / AWG 14	Tray	LCP-O510A	BLW-O510A	Control	
C-AT-O510A	1x Pair TECK90 / AWG 16	Tray	LCP-O510A	AT-O510A	Control	
C-LCP-O510A	10C Multi TECK90 / AWG 14	Tray	CP-O30	LCP-O510A	Control	
C-FCV-O520A	6C Multi TECK90 / AWG 14	Tray	LCP-O520A	FCV-O520A	Control	
C-FCV-O520A	2x Pair TECK90 / AWG 16	Tray	LCP-O520A	FCV-O520A	Control	
C-TT-O520A	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	TT-O520A	Control	
C-HTR-O520A	4C Multi TECK90 / AWG 14	Tray	LCP-O520A	HTR-O520A	Control	
C-TT-O520B	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	TT-O520B	Control	
C-CDU-O520A	4C Multi TECK90 / AWG 14	Tray	LCP-O520A	CDU-O520A	Control	
C-PT-O520A	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	PT-O520A	Control	
C-TT-O520C	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	TT-O520C	Control	
C-BLW-O520A	4C Multi TECK90 / AWG 14	Tray	LCP-O520A	BLW-O520A	Control	
C-PT-O520B	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	PT-O520B	Control	
C-AT-O520A	1x Pair TECK90 / AWG 16	Tray	LCP-O520A	AT-O520A	Control	
C-LCP-O520A	10C Multi TECK90 / AWG 14	Tray	CP-O30	LCP-O520A	Control	
C-AT-O520B	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O520B	Control	
C-PT-O505A	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O505A	Control	
C-PT-O505B	1x Pair TECK90 / AWG 16	Tray	CP-O30	PT-O505B	Control	
C-AT-O505A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O505A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FV-O523A	10C Multi TECK90 / AWG 14	Tray	CP-O30	FV-O523A	Control	
C-FCV-O530A	6C Multi TECK90 / AWG 14	Tray	LCP-O530A	FCV-O530A	Control	
C-FCV-O530A	2x Pair TECK90 / AWG 16	Tray	LCP-O530A	FCV-O530A	Control	
C-TT-O530A	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	TT-O530A	Control	
C-HTR-O530A	4C Multi TECK90 / AWG 14	Tray	LCP-O530A	HTR-O530A	Control	
C-TT-O530B	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	TT-O530B	Control	
C-CDU-O530A	4C Multi TECK90 / AWG 14	Tray	LCP-O530A	CDU-O530A	Control	
C-PT-O530A	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	PT-O530A	Control	
C-TT-O530C	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	TT-O530C	Control	
C-BLW-O530A	4C Multi TECK90 / AWG 14	Tray	LCP-O530A	BLW-O530A	Control	
C-PT-O530B	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	PT-O530B	Control	
C-AT-O530A	1x Pair TECK90 / AWG 16	Tray	LCP-O530A	AT-O530A	Control	
C-LCP-O530A	10C Multi TECK90 / AWG 14	Tray	CP-O30	LCP-O530A	Control	
C-P-O401A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	P-O401A	Control	
C-P-O402A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	P-O402A	Control	
C-P-O403A	6C Multi TECK90 / AWG 14	Tray	LCP-F01	P-O403A	Control	
C-FS-O404A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	FS-O404A	Control	
C-AT-O404A	2C Multi TECK90 / AWG 14	Tray	LCP-F01	AT-O404A	Control	
C-AT-O404A	1x Pair TECK90 / AWG 16	Tray	LCP-F01	AT-O404A	Control	
C-FV-O410A	10C Multi TECK90 / AWG 14	Tray	PSU-O310A	FV-O410A	Control	
C-TT-O410A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O410A	Control	
C-FT-O410A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	FT-O410A	Control	
C-FV-O411A	10C Multi TECK90 / AWG 14	Tray	PSU-O310A	FV-O411A	Control	
C-FT-O411A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	FT-O411A	Control	
C-PT-O411A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	PT-O411A	Control	
C-HS-O411A	3C Multi TECK90 / AWG 14	Tray	PSU-O310A	HS-O411A	Control	
C-TT-O411A	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O411A	Control	
C-FCV-O411A	6C Multi TECK90 / AWG 14	Tray	PSU-O310A	FCV-O411A	Control	
C-FCV-O411A	2x Pair TECK90 / AWG 16	Tray	PSU-O310A	FCV-O411A	Control	
C-SOL-O411A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	SOL-O411A	Control	
C-CT-O411A	1x Triad TECK90 / AWG 16	Tray	PSU-O310A	CT-O411A	Control	
C-TT-O410B	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O410B	Control	
C-TT-O411B	1x Pair TECK90 / AWG 16	Tray	PSU-O310A	TT-O411B	Control	
C-FV-O420A	10C Multi TECK90 / AWG 14	Tray	PSU-O320A	FV-O420A	Control	
C-TT-O420A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O420A	Control	
C-FT-O420A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	FT-O420A	Control	
C-FV-O421A	10C Multi TECK90 / AWG 14	Tray	PSU-O320A	FV-O421A	Control	
C-FT-O421A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	FT-O421A	Control	
C-PT-O421A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	PT-O421A	Control	
C-HS-O421A	3C Multi TECK90 / AWG 14	Tray	PSU-O320A	HS-O421A	Control	
C-TT-O421A	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O421A	Control	
C-FCV-O421A	6C Multi TECK90 / AWG 14	Tray	PSU-O320A	FCV-O421A	Control	
C-FCV-O421A	2x Pair TECK90 / AWG 16	Tray	PSU-O320A	FCV-O421A	Control	
C-SOL-O421A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	SOL-O421A	Control	
C-CT-O421A	1x Triad TECK90 / AWG 16	Tray	PSU-O320A	CT-O421A	Control	
C-TT-O420B	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O420B	Control	
C-TT-O421B	1x Pair TECK90 / AWG 16	Tray	PSU-O320A	TT-O421B	Control	
C-FV-O430A	10C Multi TECK90 / AWG 14	Tray	PSU-O330A	FV-O430A	Control	
C-TT-O430A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O430A	Control	
C-FT-O430A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	FT-O430A	Control	
C-FV-O431A	10C Multi TECK90 / AWG 14	Tray	PSU-O330A	FV-O431A	Control	
C-FT-O431A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	FT-O431A	Control	
C-PT-O431A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	PT-O431A	Control	
C-HS-O431A	3C Multi TECK90 / AWG 14	Tray	PSU-O330A	HS-O431A	Control	
C-TT-O431A	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O431A	Control	
C-FCV-O431A	6C Multi TECK90 / AWG 14	Tray	PSU-O330A	FCV-O431A	Control	
C-FCV-O431A	2x Pair TECK90 / AWG 16	Tray	PSU-O330A	FCV-O431A	Control	
C-SOL-O431A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	SOL-O431A	Control	
C-CT-O431A	1x Triad TECK90 / AWG 16	Tray	PSU-O330A	CT-O431A	Control	
C-TT-O430B	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O430B	Control	
C-TT-O431B	1x Pair TECK90 / AWG 16	Tray	PSU-O330A	TT-O431B	Control	
C-FV-O310A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	FV-O310A	Control	
C-TS-O310A	2C Multi TECK90 / AWG 14	Tray	PSU-O310A	TS-O310A	Control	
C-PSU-O310A	1x CAT5e / AWG 22	Tray	CP-O30	PSU-O310A	Control	
C-FV-O320A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	FV-O320A	Control	
C-TS-O320A	2C Multi TECK90 / AWG 14	Tray	PSU-O320A	TS-O320A	Control	
C-PSU-O320A	1x CAT5e / AWG 22	Tray	CP-O30	PSU-O320A	Control	
C-FV-O330A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	FV-O330A	Control	
C-TS-O330A	2C Multi TECK90 / AWG 14	Tray	PSU-O330A	TS-O330A	Control	
C-PSU-O330A	1x CAT5e / AWG 22	Tray	CP-O30	PSU-O330A	Control	
C-SP-O220A	6C Multi TECK90 / AWG 14	Tray	CP-O30	SP-O220A	Control	
C-HS-O220A	3C Multi TECK90 / AWG 14	Tray	CP-O30	HS-O220A	Control	
C-SP-O225A	6C Multi TECK90 / AWG 14	Tray	CP-O30	SP-O225A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-HS-O225A	3C Multi TECK90 / AWG 14	Tray	CP-O30	HS-O225A	Control	
C-FS-O221A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FS-O221A	Control	
C-AT-O221A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O221A	Control	
C-FS-O2256	2C Multi TECK90 / AWG 14	Tray	CP-O30	FS-O2256	Control	
C-AT-O226A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O226A	Control	
C-SP-O240A	6C Multi TECK90 / AWG 14	Tray	CP-O30	SP-O240A	Control	
C-HS-O240A	3C Multi TECK90 / AWG 14	Tray	CP-O30	HS-O240A	Control	
C-SP-O245A	6C Multi TECK90 / AWG 14	Tray	CP-O30	SP-O245A	Control	
C-HS-O245A	3C Multi TECK90 / AWG 14	Tray	CP-O30	HS-O245A	Control	
C-FS-O241A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FS-O241A	Control	
C-AT-O241A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O241A	Control	
C-FS-O246A	2C Multi TECK90 / AWG 14	Tray	CP-O30	FS-O246A	Control	
C-AT-O246A	1x Pair TECK90 / AWG 16	Tray	CP-O30	AT-O246A	Control	
C-SLG-R010A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R010A	Control	
C-SLG-R010B	3C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R010B	Control	
C-LS-R010A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R010A	Control	
C-LS-R010B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R010B	Control	
C-SLG-R100A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R100A	Control	
C-SLG-R200A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R200A	Control	
C-SLG-R300A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R300A	Control	
C-SLG-R400A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	SLG-R400A	Control	
C-LS-R100A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R100A	Control	
C-LS-R100B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R100B	Control	
C-FV-R100A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R100A	Control	
C-LT-R100D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R100D	Control	
C-LT-R100D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R100D	Control	
C-LT-R100E	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R100E	Control	
C-LT-R100E	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R100E	Control	
C-AY-R100C	2x Pair TECK90 / AWG 16	Tray	MCC3A	AY-R100C	Control	
C-HS-R100C	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R100C	Control	
C-MCC3A	1x CAT5e / AWG 22	Tray	CP-H10	MCC3A	Control	
C-LS-R200A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R200A	Control	
C-LS-R200B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R200B	Control	
C-FV-R200A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R200A	Control	
C-LT-R200D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R200D	Control	
C-LT-R200D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R200D	Control	
C-LT-R200E	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R200E	Control	
C-LT-R200E	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R200E	Control	
C-AY-R200C	2x Pair TECK90 / AWG 16	Tray	MCC3A	AY-R200C	Control	
C-HS-R200C	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R200C	Control	
C-MCC3A	1x CAT5e / AWG 22	Tray	CP-H10	MCC3A	Control	
C-LS-R300A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R300A	Control	
C-LS-R300B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R300B	Control	
C-FV-R300A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R300A	Control	
C-LT-R300D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R300D	Control	
C-LT-R300D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R300D	Control	
C-LT-R300E	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R300E	Control	
C-LT-R300E	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R300E	Control	
C-HS-R300C	3C Multi TECK90 / AWG 14	Tray	LCP-R21	HS-R300C	Control	
C-MCC3B	1x CAT5e / AWG 22	Tray	CP-H10	MCC3B	Control	
C-LS-R400A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R400A	Control	
C-LS-R400B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R400B	Control	
C-FV-R400A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R400A	Control	
C-LT-R400D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R400D	Control	
C-LT-R400D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R400D	Control	
C-LT-R400E	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R400E	Control	
C-LT-R400E	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R400E	Control	
C-AY-R400C	2x Pair TECK90 / AWG 16	Tray	MCC3B	AY-R400C	Control	
C-HS-R400C	3C Multi TECK90 / AWG 14	Tray	LCP-R21	HS-R400C	Control	
C-MCC3B	1x CAT5e / AWG 22	Tray	CP-H10	MCC3B	Control	
C-AT-R001A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R001A	Control	
C-AT-R001A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R001A	Control	
C-FT-R001B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	FT-R001B	Control	
C-FT-R001B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	FT-R001B	Control	
C-HS-R001C	3C Multi TECK90 / AWG 14	Tray	LCP-R001C	HS-R001C	Control	
C-LS-R001A	8C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R001A	Control	
C-SP-R010A	6C Multi TECK90 / AWG 14	Tray	LCP-R21	SP-R010A	Control	
C-FS-R010A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	FS-R010A	Control	
C-AT-R010A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R010A	Control	
C-AT-R010A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R010A	Control	
C-VT-R021A	2C Multi TECK90 / AWG 14	Tray	MCC3A	VT-R021A	Control	
C-TT-R021x	3x Pair TECK90 / AWG 16	Tray	MCC3A	TT-R021x	Control	
C-HS-R021A	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R021A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-VSD-R021B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	VSD-R021B	Control	
C-VSD-R021B	2x Pair TECK90 / AWG 16	Tray	LCP-R21	VSD-R021B	Control	
C-ST-R021B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	ST-R021B	Control	
C-SY-R021B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	SY-R021B	Control	
C-VT-R022A	2C Multi TECK90 / AWG 14	Tray	MCC3B	VT-R022A	Control	
C-TT-R022A	5x Pair TECK90 / AWG 16	Tray	MCC3B	TT-R022A	Control	
C-HS-R022A	3C Multi TECK90 / AWG 14	Tray	MCC3B	HS-R022A	Control	
C-VSD-R022A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	VSD-R022A	Control	
C-VSD-R022A	2x Pair TECK90 / AWG 16	Tray	LCP-R21	VSD-R022A	Control	
C-ST-R022A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	ST-R022A	Control	
C-SY-R022A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	SY-R022A	Control	
C-VT-R023A	2C Multi TECK90 / AWG 14	Tray	MCC3A	VT-R023A	Control	
C-TT-R023A	5x Pair TECK90 / AWG 16	Tray	MCC3A	TT-R023A	Control	
C-HS-R023A	3C Multi TECK90 / AWG 14	Tray	MCC3A	HS-R023A	Control	
C-SY-R023A	2C Multi TECK90 / AWG 14	Tray	MCC3A	SY-R023A	Control	
C-LY-R020C	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LY-R020C	Control	
C-LY-R020D	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LY-R020D	Control	
C-LS-R020A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R020A	Control	
C-LS-R020B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R020B	Control	
C-LT-R020A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R020A	Control	
C-LT-R020A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R020A	Control	
C-FV-R021B	6C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R021B	Control	
C-FV-R022B	6C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R022B	Control	
C-FV-R023B	6C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R023B	Control	
C-AT-R024A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R024A	Control	
C-AT-R024A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R024A	Control	
C-PRV-R024A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	PRV-R024A	Control	
C-HV-R021A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	HV-R021A	Control	
C-HV-R022A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	HV-R022A	Control	
C-HV-R023A	3C Multi TECK90 / AWG 14	Tray	LCP-R21	HV-R023A	Control	
C-FV-R024B	6C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R024B	Control	
C-FT-R024A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	FT-R024A	Control	
C-FT-R024A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	FT-R024A	Control	
C-LS-R500A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R500A	Control	
C-LCP-R500A	10C Multi TECK90 / AWG 14	Tray	LCP-R21	LCP-R500A	Control	
C-VSD-R500A	2C Multi TECK90 / AWG 14	Tray	LCP-R500A	VSD-R500A	Control	
C-AT-R500B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R500B	Control	
C-AT-R500B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R500B	Control	
C-AT-R500C	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R500C	Control	
C-AT-R500C	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R500C	Control	
C-LS-R600A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R600A	Control	
C-LCP-R600A	10C Multi TECK90 / AWG 14	Tray	LCP-R21	LCP-R600A	Control	
C-VSD-R600A	2C Multi TECK90 / AWG 14	Tray	LCP-R600A	VSD-R600A	Control	
C-AT-R600B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R600B	Control	
C-AT-R600B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R600B	Control	
C-AT-R600C	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R600C	Control	
C-AT-R600C	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R600C	Control	
C-FT-R730A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	FT-R730A	Control	
C-FT-R730A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	FT-R730A	Control	
C-AT-R730B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R730B	Control	
C-AT-R730B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R730B	Control	
C-FV-R730A	6C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R730A	Control	
C-FV-R710A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R710A	Control	
C-MCC3A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC3A	Control	
C-MCC3A	2x Pair TECK90 / AWG 16	Tray	CP-H10	MCC3A	Control	
C-LT-R710D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R710D	Control	
C-LT-R710D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R710D	Control	
C-LS-R710A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R710A	Control	
C-LS-R710B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R710B	Control	
C-HS-R710C	3C Multi TECK90 / AWG 14	Tray	LCP-R710C	HS-R710C	Control	
C-LCP-R710C	8C Multi TECK90 / AWG 14	Tray	LCP-R21	LCP-R710C	Control	
C-LCP-R710C	2x Pair TECK90 / AWG 16	Tray	LCP-R21	LCP-R710C	Control	
C-V-R700A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	V-R700A	Control	
C-MCC3B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC3B	Control	
C-MCC3B	2x Pair TECK90 / AWG 16	Tray	CP-H10	MCC3B	Control	
C-LT-R720D	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R720D	Control	
C-LT-R720D	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R720D	Control	
C-LS-R720A	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R720A	Control	
C-LS-R720B	2C Multi TECK90 / AWG 14	Tray	LCP-R21	LS-R720B	Control	
C-LCP-R720C	8C Multi TECK90 / AWG 14	Tray	LCP-R21	LCP-R720C	Control	
C-LCP-R720C	2x Pair TECK90 / AWG 16	Tray	LCP-R21	LCP-R720C	Control	
C-FV-R720A	7C Multi TECK90 / AWG 14	Tray	LCP-R21	FV-R720A	Control	
C-LT-R900	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R900	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-LT-R900	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R900	Control	
C-LT-R920	4C Multi TECK90 / AWG 14	Tray	LCP-R21	LT-R920	Control	
C-LT-R920	1x Pair TECK90 / AWG 16	Tray	LCP-R21	LT-R920	Control	
C-AT-R924A	4C Multi TECK90 / AWG 14	Tray	LCP-R21	AT-R924A	Control	
C-AT-R924A	1x Pair TECK90 / AWG 16	Tray	LCP-R21	AT-R924A	Control	
C-FIT-R924B	4C Multi TECK90 / AWG 14	Tray	LCP-R21	FIT-R924B	Control	
C-FIT-R924B	1x Pair TECK90 / AWG 16	Tray	LCP-R21	FIT-R924B	Control	
C-TT-I011A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	TT-I011A	Control	
C-AT-I024B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	AT-I024B	Control	
C-FS-I024B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I024B	Control	
C-PT-I011B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	PT-I011B	Control	
C-PT-I011B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	PT-I011B	Control	
C-FS-I022E	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I022E	Control	
C-FS-I023E	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I023E	Control	
C-TT-I012A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	TT-I012A	Control	
C-PT-I012B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	PT-I012B	Control	
C-PT-I012B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	PT-I012B	Control	
C-AT-I027B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	AT-I027B	Control	
C-FS-I027B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I027B	Control	
C-HS-I013A	3C Multi TECK90 / AWG 14	Tray	MCC1A	HS-I013A	Control	
C-MCC1A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC1A	Control	
C-HS-I014A	3C Multi TECK90 / AWG 14	Tray	MCC1A	HS-I014A	Control	
C-MCC1A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC1A	Control	
C-HS-I015A	3C Multi TECK90 / AWG 14	Tray	MCC1B	HS-I015A	Control	
C-MCC1B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC1B	Control	
C-HV-I013D	2C Multi TECK90 / AWG 14	Tray	TJB-A11	HV-I013D	Control	
C-FV-I014D	7C Multi TECK90 / AWG 14	Tray	TJB-A11	FV-I014D	Control	
C-HV-I015D	2C Multi TECK90 / AWG 14	Tray	TJB-A11	HV-I015D	Control	
C-FV-I014E	7C Multi TECK90 / AWG 14	Tray	TJB-A11	FV-I014E	Control	
C-AT-I025B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	AT-I025B	Control	
C-FS-I025B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I025B	Control	
C-FS-I017D	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I017D	Control	
C-FS-I018D	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I018D	Control	
C-FS-I026B	2C Multi TECK90 / AWG 14	Tray	TJB-A11	FS-I026B	Control	
C-AT-I026B	1x Pair TECK90 / AWG 16	Tray	TJB-A11	AT-I026B	Control	
C-FT-P100A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P100A	Control	
C-FT-P100A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P100A	Control	
C-FCV-P100A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P100A	Control	
C-FCV-P100A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P100A	Control	
C-FT-P200A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P200A	Control	
C-FT-P200A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P200A	Control	
C-FCV-P200A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P200A	Control	
C-FCV-P200A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P200A	Control	
C-FT-P300A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P300A	Control	
C-FT-P300A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P300A	Control	
C-FCV-P300A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P300A	Control	
C-FCV-P300A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P300A	Control	
C-FT-P400A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P400A	Control	
C-FT-P400A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P400A	Control	
C-FCV-P400A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P400A	Control	
C-FCV-P400A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P400A	Control	
C-FT-P500A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P500A	Control	
C-FT-P500A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P500A	Control	
C-FCV-P500A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P500A	Control	
C-FCV-P500A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P500A	Control	
C-FT-P600A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P600A	Control	
C-FT-P600A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P600A	Control	
C-FCV-P600A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P600A	Control	
C-FCV-P600A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P600A	Control	
C-FT-P700A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P700A	Control	
C-FT-P700A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P700A	Control	
C-FCV-P700A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P700A	Control	
C-FCV-P700A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P700A	Control	
C-FT-P800A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	FT-P800A	Control	
C-FT-P800A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	FT-P800A	Control	
C-FCV-P800A	6C Multi TECK90 / AWG 14	Tray	TJB-A11	FCV-P800A	Control	
C-FCV-P800A	2x Pair TECK90 / AWG 16	Tray	TJB-A11	FCV-P800A	Control	
C-DF-P100A	4C Multi TECK90 / AWG 14	Tray	LCP-P31	DF-P100A	Control	
C-LCP-P31	1x CAT5e / AWG 22	Tray	CP-P31	LCP-P31	Control	
C-SOL-P120A	2C Multi TECK90 / AWG 14	Tray	LCP-P31	SOL-P120A	Control	
C-SOL-P120B	2C Multi TECK90 / AWG 14	Tray	LCP-P31	SOL-P120B	Control	
C-LT-P100A	4C Multi TECK90 / AWG 14	Tray	LCP-P31	LT-P100A	Control	
C-LT-P100A	1x Pair TECK90 / AWG 16	Tray	LCP-P31	LT-P100A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-SLG-P140A	6C Multi TECK90 / AWG 14	Tray	CP-P31	SLG-P140A	Control	
C-SLG-P140A	2x Pair TECK90 / AWG 16	Tray	CP-P31	SLG-P140A	Control	
C-FV-P110A	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P110A	Control	
C-FV-P110B	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P110B	Control	
C-DF-P200A	4C Multi TECK90 / AWG 14	Tray	LCP-P32	DF-P200A	Control	
C-LCP-P32	1x CAT5e / AWG 22	Tray	CP-P31	LCP-P32	Control	
C-SOL-P220A	2C Multi TECK90 / AWG 14	Tray	LCP-P32	SOL-P220A	Control	
C-SOL-P220B	2C Multi TECK90 / AWG 14	Tray	LCP-P32	SOL-P220B	Control	
C-LT-P200A	4C Multi TECK90 / AWG 14	Tray	LCP-P32	LT-P200A	Control	
C-LT-P200A	1x Pair TECK90 / AWG 16	Tray	LCP-P32	LT-P200A	Control	
C-SLG-P240A	6C Multi TECK90 / AWG 14	Tray	CP-P31	SLG-P240A	Control	
C-SLG-P240A	2x Pair TECK90 / AWG 16	Tray	CP-P31	SLG-P240A	Control	
C-FV-P210A	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P210A	Control	
C-FV-P210B	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P210B	Control	
C-DF-P300A	4C Multi TECK90 / AWG 14	Tray	LCP-P33	DF-P300A	Control	
C-LCP-P33	1x CAT5e / AWG 22	Tray	CP-P31	LCP-P33	Control	
C-SOL-P320A	2C Multi TECK90 / AWG 14	Tray	LCP-P33	SOL-P320A	Control	
C-SOL-P320B	2C Multi TECK90 / AWG 14	Tray	LCP-P33	SOL-P320B	Control	
C-LT-P300A	4C Multi TECK90 / AWG 14	Tray	LCP-P33	LT-P300A	Control	
C-LT-P300A	1x Pair TECK90 / AWG 16	Tray	LCP-P33	LT-P300A	Control	
C-SLG-P340A	6C Multi TECK90 / AWG 14	Tray	CP-P31	SLG-P340A	Control	
C-SLG-P340A	2x Pair TECK90 / AWG 16	Tray	CP-P31	SLG-P340A	Control	
C-FV-P310A	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P310A	Control	
C-FV-P310B	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P310B	Control	
C-DF-P400A	4C Multi TECK90 / AWG 14	Tray	LCP-P34	DF-P400A	Control	
C-LCP-P34	1x CAT5e / AWG 22	Tray	CP-P31	LCP-P34	Control	
C-SOL-P420A	2C Multi TECK90 / AWG 14	Tray	LCP-P34	SOL-P420A	Control	
C-SOL-P420B	2C Multi TECK90 / AWG 14	Tray	LCP-P34	SOL-P420B	Control	
C-LT-P400A	4C Multi TECK90 / AWG 14	Tray	LCP-P34	LT-P400A	Control	
C-LT-P400A	1x Pair TECK90 / AWG 16	Tray	LCP-P34	LT-P400A	Control	
C-SLG-P440A	6C Multi TECK90 / AWG 14	Tray	CP-P31	SLG-P440A	Control	
C-SLG-P440A	2x Pair TECK90 / AWG 16	Tray	CP-P31	SLG-P440A	Control	
C-FV-P410A	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P410A	Control	
C-FV-P410B	7C Multi TECK90 / AWG 14	Tray	CP-P31	FV-P410B	Control	
C-DF-P500A	4C Multi TECK90 / AWG 14	Tray	LCP-P35	DF-P500A	Control	
C-LCP-P35	1x CAT5e / AWG 22	Tray	TJB-P33	LCP-P35	Control	
C-SOL-P520A	2C Multi TECK90 / AWG 14	Tray	LCP-P35	SOL-P520A	Control	
C-SOL-P520B	2C Multi TECK90 / AWG 14	Tray	LCP-P35	SOL-P520B	Control	
C-LT-P500A	4C Multi TECK90 / AWG 14	Tray	LCP-P35	LT-P500A	Control	
C-LT-P500A	1x Pair TECK90 / AWG 16	Tray	LCP-P35	LT-P500A	Control	
C-SLG-P540A	6C Multi TECK90 / AWG 14	Tray	TJB-P33	SLG-P540A	Control	
C-SLG-P540A	2x Pair TECK90 / AWG 16	Tray	TJB-P33	SLG-P540A	Control	
C-FV-P510A	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P510A	Control	
C-FV-P510B	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P510B	Control	
C-DF-P600A	4C Multi TECK90 / AWG 14	Tray	LCP-P36	DF-P600A	Control	
C-LCP-P36	1x CAT5e / AWG 22	Tray	TJB-P33	LCP-P36	Control	
C-SOL-P620A	2C Multi TECK90 / AWG 14	Tray	LCP-P36	SOL-P620A	Control	
C-SOL-P620B	2C Multi TECK90 / AWG 14	Tray	LCP-P36	SOL-P620B	Control	
C-LT-P600A	4C Multi TECK90 / AWG 14	Tray	LCP-P36	LT-P600A	Control	
C-LT-P600A	1x Pair TECK90 / AWG 16	Tray	LCP-P36	LT-P600A	Control	
C-SLG-P640A	6C Multi TECK90 / AWG 14	Tray	TJB-P33	SLG-P640A	Control	
C-SLG-P640A	2x Pair TECK90 / AWG 16	Tray	TJB-P33	SLG-P640A	Control	
C-FV-P610A	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P610A	Control	
C-FV-P610B	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P610B	Control	
C-DF-P700A	4C Multi TECK90 / AWG 14	Tray	LCP-P37	DF-P700A	Control	
C-LCP-P37	1x CAT5e / AWG 22	Tray	TJB-P33	LCP-P37	Control	
C-SOL-P720A	2C Multi TECK90 / AWG 14	Tray	LCP-P37	SOL-P720A	Control	
C-SOL-P720B	2C Multi TECK90 / AWG 14	Tray	LCP-P37	SOL-P720B	Control	
C-LT-P700A	4C Multi TECK90 / AWG 14	Tray	LCP-P37	LT-P700A	Control	
C-LT-P700A	1x Pair TECK90 / AWG 16	Tray	LCP-P37	LT-P700A	Control	
C-SLG-P740A	6C Multi TECK90 / AWG 14	Tray	TJB-P33	SLG-P740A	Control	
C-SLG-P740A	2x Pair TECK90 / AWG 16	Tray	TJB-P33	SLG-P740A	Control	
C-FV-P710A	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P710A	Control	
C-FV-P710B	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P710B	Control	
C-DF-P800A	4C Multi TECK90 / AWG 14	Tray	LCP-P38	DF-P800A	Control	
C-LCP-P38	1x CAT5e / AWG 22	Tray	TJB-P33	LCP-P38	Control	
C-SOL-P820A	2C Multi TECK90 / AWG 14	Tray	LCP-P38	SOL-P820A	Control	
C-SOL-P820B	2C Multi TECK90 / AWG 14	Tray	LCP-P38	SOL-P820B	Control	
C-LT-P800A	4C Multi TECK90 / AWG 14	Tray	LCP-P38	LT-P800A	Control	
C-LT-P800A	1x Pair TECK90 / AWG 16	Tray	LCP-P38	LT-P800A	Control	
C-SLG-P840A	6C Multi TECK90 / AWG 14	Tray	TJB-P33	SLG-P840A	Control	
C-SLG-P840A	2x Pair TECK90 / AWG 16	Tray	TJB-P33	SLG-P840A	Control	
C-FV-P810A	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P810A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-FV-P810B	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P810B	Control	
C-P-P010A	3x Pair TECK90 / AWG 16	Tray	LCP-P010A	P-P010A	Control	
C-P-P010A	1x CAT5e / AWG 22	Tray	TJB-P11	P-P010A	Control	
C-HV-P010C	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P010C	Control	
C-P-P020A	3x Pair TECK90 / AWG 16	Tray	LCP-P020A	P-P020A	Control	
C-P-P020A	1x CAT5e / AWG 22	Tray	TJB-P11	P-P020A	Control	
C-P-P030A	3x Pair TECK90 / AWG 16	Tray	LCP-P030A	P-P030A	Control	
C-P-P030A	1x CAT5e / AWG 22	Tray	TJB-P11	P-P030A	Control	
C-FV-P020D	7C Multi TECK90 / AWG 14	Tray	TJB-O11	FV-P020D	Control	
C-FV-P020E	7C Multi TECK90 / AWG 14	Tray	TJB-O11	FV-P020E	Control	
C-HV-P030C	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P030C	Control	
C-FIT-P001A	2C Multi TECK90 / AWG 14	Tray	CP-P31	FIT-P001A	Control	
C-FIT-P001A	1x Pair TECK90 / AWG 16	Tray	CP-P31	FIT-P001A	Control	
C-PIT-P001A	1x Pair TECK90 / AWG 16	Tray	CP-P31	PIT-P001A	Control	
C-LT-P001A	4C Multi TECK90 / AWG 14	Tray	CP-P31	LT-P001A	Control	
C-LT-P001A	1x Pair TECK90 / AWG 16	Tray	CP-P31	LT-P001A	Control	
C-LSL-P001A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	LSL-P001A	Control	
C-PSL-P001A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	PSL-P001A	Control	
C-TIT-P001A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	TIT-P001A	Control	
C-FV-P001A	7C Multi TECK90 / AWG 14	Tray	TJB-P33	FV-P001A	Control	
C-SOL-P001A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	SOL-P001A	Control	
C-FIT-P002A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	FIT-P002A	Control	
C-FIT-P002A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	FIT-P002A	Control	
C-PIT-P002A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	PIT-P002A	Control	
C-LT-P002A	4C Multi TECK90 / AWG 14	Tray	TJB-P33	LT-P002A	Control	
C-LT-P002A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	LT-P002A	Control	
C-LSL-P002A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	LSL-P002A	Control	
C-PSL-P002A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	PSL-P002A	Control	
C-TIT-P002A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	TIT-P002A	Control	
C-SOL-P002A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	SOL-P002A	Control	
C-P-P040A	3x Pair TECK90 / AWG 16	Tray	LCP-P040A	P-P040A	Control	
C-P-P040A	1x CAT5e / AWG 22	Tray	LCP-P040A	P-P040A	Control	
C-HV-P040C	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P040C	Control	
C-P-P050A	3x Pair TECK90 / AWG 16	Tray	LCP-P050A	P-P050A	Control	
C-P-P050A	1x CAT5e / AWG 22	Tray	LCP-P050A	P-P050A	Control	
C-P-P060A	3x Pair TECK90 / AWG 16	Tray	LCP-P060A	P-P060A	Control	
C-P-P060A	1x CAT5e / AWG 22	Tray	LCP-P060A	P-P060A	Control	
C-FV-P050D	7C Multi TECK90 / AWG 14	Tray	TJB-O11	FV-P050D	Control	
C-FV-P050E	7C Multi TECK90 / AWG 14	Tray	TJB-O11	FV-P050E	Control	
C-HV-P060C	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P060C	Control	
C-FIT-P003A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	FIT-P003A	Control	
C-FIT-P003A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	FIT-P003A	Control	
C-PIT-P003A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	PIT-P003A	Control	
C-LT-P003A	4C Multi TECK90 / AWG 14	Tray	TJB-P34	LT-P003A	Control	
C-LT-P003A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	LT-P003A	Control	
C-LSL-P003A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	LSL-P003A	Control	
C-PSL-P003A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	PSL-P003A	Control	
C-TIT-P003A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	TIT-P003A	Control	
C-SOL-P003A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	SOL-P003A	Control	
C-FIT-P004A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	FIT-P004A	Control	
C-FIT-P004A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	FIT-P004A	Control	
C-PIT-P004A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	PIT-P004A	Control	
C-LT-P004A	4C Multi TECK90 / AWG 14	Tray	TJB-P34	LT-P004A	Control	
C-LT-P004A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	LT-P004A	Control	
C-LSL-P004A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	LSL-P004A	Control	
C-PSL-P004A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	PSL-P004A	Control	
C-TIT-P004A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	TIT-P004A	Control	
C-SOL-P004A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	SOL-P004A	Control	
C-LCP-P910A	4C Multi TECK90 / AWG 14	Tray	CP-H30	LCP-P910A	Control	
C-LCP-P920A	4C Multi TECK90 / AWG 14	Tray	CP-H30	LCP-P920A	Control	
C-PIT-P900A	1x Pair TECK90 / AWG 16	Tray	CP-H30	PIT-P900A	Control	
C-LSHH-P970A	2C Multi TECK90 / AWG 14	Tray	TJB-P33	LSHH-P970A	Control	
C-LT-P970A	4C Multi TECK90 / AWG 14	Tray	TJB-P33	LT-P970A	Control	
C-LT-P970A	1x Pair TECK90 / AWG 16	Tray	TJB-P33	LT-P970A	Control	
C-LSHH-P971A	2C Multi TECK90 / AWG 14	Tray	TJB-P34	LSHH-P971A	Control	
C-LT-P971A	4C Multi TECK90 / AWG 14	Tray	TJB-P34	LT-P971A	Control	
C-LT-P971A	1x Pair TECK90 / AWG 16	Tray	TJB-P34	LT-P971A	Control	
C-FS-P975A	2C Multi TECK90 / AWG 14	Tray	CP-P31	FS-P975A	Control	
C-AT-P975A	1x Pair TECK90 / AWG 16	Tray	CP-P31	AT-P975A	Control	
C-LT-P930A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P930A	Control	
C-LT-P930B	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P930B	Control	
C-HS-P931A	3C Multi TECK90 / AWG 14	Tray	MCC2A	HS-P931A	Control	
C-MCC2A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2A	Control	

CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
C-HV-P931E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P931E	Control	
C-HS-P932A	3C Multi TECK90 / AWG 14	Tray	MCC2A	HS-P932A	Control	
C-MCC2A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2A	Control	
C-HV-P932E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P932E	Control	
C-LT-P940A	4C Multi TECK90 / AWG 14	Tray	TJB-O11	LT-P940A	Control	
C-LT-P940A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P940A	Control	
C-LT-P940B	4C Multi TECK90 / AWG 14	Tray	TJB-O11	LT-P940B	Control	
C-LT-P940B	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P940B	Control	
C-HS-P941A	3C Multi TECK90 / AWG 14	Tray	MCC2A	HS-P941A	Control	
C-MCC2A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2A	Control	
C-HV-P941E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P941E	Control	
C-HS-P942A	3C Multi TECK90 / AWG 14	Tray	MCC2A	HS-P942A	Control	
C-MCC2A	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2A	Control	
C-HV-P942E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P942E	Control	
C-FT-P990A	2C Multi TECK90 / AWG 14	Tray	TJB-O11	FT-P990A	Control	
C-FT-P990A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	FT-P990A	Control	
C-LT-P950A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P950A	Control	
C-LT-P950B	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P950B	Control	
C-HS-P951A	3C Multi TECK90 / AWG 14	Tray	MCC2B	HS-P951A	Control	
C-MCC2B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2B	Control	
C-HV-P951E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P951E	Control	
C-HS-P952A	3C Multi TECK90 / AWG 14	Tray	MCC2B	HS-P952A	Control	
C-MCC2B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2B	Control	
C-HV-P952E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P952E	Control	
C-LT-P960A	4C Multi TECK90 / AWG 14	Tray	TJB-O11	LT-P960A	Control	
C-LT-P960A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P960A	Control	
C-LT-P960B	4C Multi TECK90 / AWG 14	Tray	TJB-O11	LT-P960B	Control	
C-LT-P960B	1x Pair TECK90 / AWG 16	Tray	TJB-O11	LT-P960B	Control	
C-HS-P961A	3C Multi TECK90 / AWG 14	Tray	MCC2B	HS-P961A	Control	
C-MCC2B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2B	Control	
C-HV-P961E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P961E	Control	
C-HS-P962A	3C Multi TECK90 / AWG 14	Tray	MCC2B	HS-P962A	Control	
C-MCC2B	8C Multi TECK90 / AWG 14	Tray	CP-H10	MCC2B	Control	
C-HV-P962E	2C Multi TECK90 / AWG 14	Tray	TJB-O11	HV-P962E	Control	
C-FT-P993A	2C Multi TECK90 / AWG 14	Tray	TJB-O11	FT-P993A	Control	
C-FT-P993A	1x Pair TECK90 / AWG 16	Tray	TJB-O11	FT-P993A	Control	
C-LT-P980A	4C Multi TECK90 / AWG 14	Tray	TJB-A11	LT-P980A	Control	
C-LT-P980A	1x Pair TECK90 / AWG 16	Tray	TJB-A11	LT-P980A	Control	
C-LS-H500C	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H500C	Control	
C-LS-H500D	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H500D	Control	
C-LS-H500B	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H500B	Control	
C-LS-H500A	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H500A	Control	
C-LS-H510C	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H510C	Control	
C-LS-H510D	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H510D	Control	
C-LS-H510B	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H510B	Control	
C-LS-H510A	2C Multi TECK90 / AWG 14	Tray	LCP-H500A	LS-H510A	Control	
C-LS-H520A	2C Multi TECK90 / AWG 14	Tray	LCP-H510A	LS-H520A	Control	
C-LS-H520B	2C Multi TECK90 / AWG 14	Tray	LCP-H521A	LS-H520B	Control	
C-LCP-H510D	8C Multi TECK90 / AWG 14	Tray	CP-H10	LCP-H510D	Control	
C-P-H701A	2C Multi TECK90 / AWG 14	Tray	CP-H10	P-H701A	Control	
C-LCP-H700A	1x CAT5e / AWG 22	Tray	CP-H10A	LCP-H700A	Control	
C-LCP-H700A	1x CAT5e / AWG 22	Tray	CP-H10A	LCP-H700A	Control	

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 11, 14, 15 and 17

1.2 Requirements

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the Drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to all City Supplied Equipment and equipment supplied under any Division of these Specifications. Examine the Drawings and Shop Drawings of all Divisions and of all City Supplied Equipment for the extent of electrically operated equipment supplied by others.

.3 All control wiring diagrams shown on the Drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different Manufacturers of equipment. Verify all control circuits with Supply Contractors and others responsible for the installation of equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine Drawings and Shop Drawings of other Divisions to obtain exact location of motors and equipment shown on Drawings. Where necessary, obtain conduit locations from other trades' Drawings and Shop Drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide three phase starters with fused 120 V control transformers and overload relays.

.9 Provide all power wiring for all motors and control wiring as indicated on the Drawings.

.10 Refer to Motor Control Single Line Drawings, Control Diagrams and Cable Block Diagrams.

CONNECTIONS TO MECHANICAL EQUIPMENT

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use EEMAC 4 enclosures outdoors and in process areas, and EEMAC 1 indoors. Switches to be H.P. rated, heavy duty type.

.2 See Section 16141 Wiring Devices for DAF and Filter Gallery equipment disconnect devices.

2.2 120 V, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

2.3 208 V, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay.

3. EXECUTION

3.1 Installation

.1 Supply and install disconnect switches adjacent to motors as specified.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Provide control wiring as indicated on the Drawings and the motor control schedules.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT SYSTEMS

1. GENERAL

1.1 Related Work

.1 Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems

.2 Section 16990 – Electrical Equipment and Systems Demonstration and Instruction

1.2 Coordination

.1 Coordinates starting of electrical equipment and systems with testing, adjusting and balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 16

.2 Mechanical equipment and systems specified in Division 15

.3 Other equipment and systems specified in other Divisions.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Energizing Main Electrical System

.1 Prior to energizing main electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

.1 Verify phase rotation at motor control centres.

.2 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by the City.

.2 Confirm equipment nameplate data with characteristics of power supply.

END OF SECTION

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform with applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the City, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Section 16010 – Electrical General Requirements.

.2 Section 16030 – Electrical Testing

.3 Section 16960 – Starting of Electrical Equipment and Systems.

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by EEMAC and CSA standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Contract Administrator for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents

.2 Requirements of authorities having jurisdiction

.3 Manufacturer's published instructions

.4 Applicable CSA, IEEE, IPCEA, EEMAC, and ASTM standards

.2 If requirements of any of the foregoing conflict, notify Contract Administrator before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the Site services of qualified Manufacturer's representatives where Site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 V megger. Resistance values shall be as recommended by cable Manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

.1 Measure ground resistance with earth test meter to verify compliance with CSA C22.2 No. 0.4 and Canadian Electrical Code.

3.3 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, MCC and panelboards.

.4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.4 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

.2 Test voltage at all elevators.

.3 Test voltage at motor control centre.

.4 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Contract Administrator.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATIONS AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize City's O&M personnel with electrical systems and their O&M.

.2 Submit Form 103s for each system listed prior to Substantial Performance.

.3 Complete a motor survey sheet for each motor and submit prior to Substantial Performance. Include a control wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the O&M manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified Manufacturer’s Representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/City Coordination

.1 The Contract Administrator will chair demonstration and instruction sessions.

.2 The Contractor shall establish agendas for demonstration and instruction sessions in conjunction with the Contract Administrator.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of following systems:

.1 Primary Distribution and Transformer

.2 600/347 V Electrical System Emergency and Normal

.3 208/120 V System Emergency and Normal

.4 Pump Protection Panels

.5 Mechanical Equipment Connections and Controls

.6 Grounding System

.7 Future Connection Points and Conduit Stubs

ELECTRICAL EQUIPMENT AND SYSTEMS
DEMONSTRATIONS AND INSTRUCTION

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer_____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____ / _____/_____ Insulation Class_____

AMPS _____ / _____/_____ EEMAC Design _____

PHASE _____ Time Rating_____

Frame _____ Type_____

Serial #

Model # _____

Starter _____Type _____

OPERATING CONDITIONS

Full Load Operating Amps _____ A _____ B_____C

Full Load Operating Voltage _____ A-B _____ B-C_____C-A
at Motor

Overload Relay Installed_____ Adjustable Setting _____ %

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 5 seconds) _____

Reduced Voltage Starter Tap Setting _____

Reduced Voltage Starter Transition Time Setting _____

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.

_____

_____

CONTROL PANELS

1. GENERAL

1.1 Summary

.1 Comply with Division 1 - General Requirements and Section 16010 - Electrical General Requirements.

.2 Products installed, but not supplied under work of this section: Control panels forming part of an engineered package. Refer to other of Specification.

1.2 Submittals

.1 Submit shop drawings of control panels and components showing dimensioned internal and external layouts, terminal block arrangements, construction details, material of construction and complete component Bills of Material.

.2 Submit prior to panel delivery, complete wiring diagrams showing wiring between panel components and devices and panel terminal blocks, and between panel terminal blocks and remote equipment. Identify components, conductors and terminal blocks.

.3 Submit final record wiring diagrams at completion of project. Include changes made during field installation and start-up.

2. PRODUCTS

2.1 Manufactured Units

.1 Control panels: complete working system with instruments, meters, indicating lights, alarm annunciators, relays, contactors, switches auxiliary devices and similar items.

.2 Arrangement of instruments and devices face-mounted as well as rear-of-panel mounted: Allow sufficient access for maintenance.

.3 Mounting Height: Indicating devices, controls and instruments between 1000 mm and 2000 mm above finished floor. Allow for housekeeping pads, pedestals and similar items.

.4 Side or back face mounted devices: On removable backplate. Direct mounted devices will not be accepted.

.5 Nameplates: Removable, lamacoid, to identify panel and equipment function, letters minimum 6 mm, fasten with stainless steel screws. Grind screws flush on inside of panel so no sharp edges protrude.

.6 Supply panels complete with wiring and header piping connections.

2.2 Enclosure

.1 Dry areas: Rigid, dead front, 2 mm steel sheet, CSA 12 unless otherwise indicated.

.2 Wet and damp areas: Rigid, dead front, 2 mm steel sheet CSA 4 or 4X(as per Section 16010 ELECTRICAL GENERAL REQUIREMENTS), with stainless steel hardware.

.3 Corrosive areas: Rigid, dead front, 2 mm CSA 4X.

.4 Hazardous areas: Assembly and components suitable for application in specific areas indicated.

.5 Visible welding seams: Not acceptable.

.6 Back plate: 2.7 mm steel sheet mounted on four 10 mm collar studs minimum with stainless steel hardware.

.7 Doors: Removable, [gasketted], continuous piano type hinges, three point latching, lockable handle, keyed alike.

.8 Print pocket: On inside of door, rigid, for storing manual, layout drawings and wiring diagrams.

.9 Finish: Steel sheet phosphatize, zinc chromate prime, baked enamel inside and outside, matte white interior and ANSI 61 grey exterior.

2.3 Internal Assembly

.1 Internal component and equipment mounting: On hinged sub-chasses, racks and back plates, arranged for ease of access and removal.

.2 Pans and rails: For mounting terminal blocks, relays, contactors, wiring and similar devices.

.3 Luminaire: For floor mounted panels, fluorescent, guarded, with light switch.

.4 Receptacle: For floor mounted panels, 120 V AC, 15 A, duplex, U ground type.

.5 Outdoor panels: 120 V AC space heater with thermostat to maintain interior temperature above 5°C.

.6 Power supply disconnecting devices: To disconnect incoming power supply sources and individual feeder circuit supplies, moulded case circuit breakers, 18,000 A [22,000 A] interrupting capacity.

.7 Instrument disconnecting devices: Moulded case circuit breakers, 5,000 A symmetrical interrupting capacity for each instrument requiring 120 V supply.

.8 Identification: Identify switches, circuit breakers, components, terminal blocks, power supplies, relays, wiring and similar devices. Comply with Sections 16010.

.9 Warning signs: Identify sources of supply. Comply with Section 16010.

.10 Wiring ducts: Maximum 50% fill, with snap-on cover, by Panduit Canada.

2.4 Terminal Blocks

.1 Terminal blocks: Modular, rated 600 V 25 A minimum, tubular clamp type, 35 mm DIN rail mounted, individually removable, with removable insulating covers on exposed terminals carrying above 50 V, SAK Series by Weidmuller Ltd., UL Series by Phoenix Terminal Blocks Ltd., WK/4 Series by Wieland Electric Ltd. and Entrelec.

.2 Mounting: 150 mm minimum wiring space between rows of terminal blocks.

.3 Arrangement: Separate terminals and wiring by class of signal.

.4 Field instrument connections to SCADA: Terminal blocks, Type SAKC4 complete with test sockets both sides and type PS 2.3 test plug by Weidmuller Ltd.

.5 Spares: Minimum 20% spare terminals for each signal class.

2.5 Instrument Grounding

.1 Ground: Full length tin plated copper ground bus or ground stud with tin plated copper lugs at ends, suitable for minimum #4 AWG ground wire.

.2 Instrument cable shields and equipment ground conductors connections: With screws and clamp washers.

.3 Comply with Section 16450.

2.6 Operator Devices

.1 CSA 1 and CSA 12 panels: Heavy duty, industrial, oil-tight, rated 120 V AC, Type K by Square D Canada, Type CR104P by GE Canada, Type PB1 by Westinghouse Canada, Type 800T by Allen-Bradley Canada Ltd.

.2 CSA 4 and 4X panels: CSA 4X, Type 800H by Allen-Bradley Canada Ltd., Type SK by Square D Canada, Type PB1 or PB2 with rubber boot and legend plate gasket by Westinghouse Canada.

.3 Corrosion protection: Hermetically sealed contacts, Type 800T-XAP by Allen-Bradley Canada Ltd.

.4 CSA 1 and CSA 12 indicating lights: Integral transformer type, push-to-test, Type 800 T by Allen-Bradley Canada Ltd., Type KT by Square D Canada.

.5 CSA 4 and CSA 4X panel indication lights: CSA 4X, integral transformer, push-to-test type Type SKT-1X9 by Square D Canada, Type 800H Allen-Bradley Canada Ltd.

.6 Indicator lamps: Clustered LED] type, replaceable from front.

2.7 Motor, Heater and Lighting Control Circuit Relays

.1 General purpose relays: Heavy duty, industrial, CSA rated, electrically held, 120 V AC coil, 10 A, 120 V AC convertible contacts, Type P by Allen-Bradley Canada Ltd., Type X by Square D Canada.

.2 Magnetic latching relays: Heavy duty, industrial, CSA rated, magnetically held, electrically released, 120 V AC coil, 120 V AC, 10 A, convertible contacts, Type NM by Allen-Bradley Canada Ltd., Type XL by Square D Canada.

.3 Timing relays: ON delay, OFF delay or Interval type as indicated, 120 V AC coil, 120 V AC, 10 A convertible contacts, knob adjustable timing range, Type PT, or NT by Allen-Bradley Canada Ltd., Type X by Square D Canada, or Type ARPT by Westinghouse Canada.

.4 Double voltage relays: Convertible contacts, number and type as indicated, with metal barrier between coil and contact terminations where indicated or required by the Inspection Authorities.

2.8 General Purpose Control Relays

.1 General purpose relays: Electrically held, 120 V coil, 60 Hz, enclosed, three 5 A, 120 V AC, form C contacts minimum, screw terminal socket mount, with hold down clips, pilot light and push-to-test button, Type KUP by Potter & Brumfield Inc., Type 700 HA by Allen-Bradley Canada Ltd.

.2 Latching relays: Magnetic type, magnetically held, electrically released, 120 V AC coil, enclosed, with two 10 amp, 120 V AC form C contacts, screw terminal socket mount, with hold down clips. Type KUL by Potter & Brumfield Inc.

.3 Timing relays: Solid state, ON delay, OFF delay or Interval type as indicated, 120 V AC coil, two 10 A, 120 V AC, form C contacts, screw terminal socket mount, knob adjustable timing, timing range as indicated. CK Series (up to 60 seconds ranges), CG Series (greater than 60 seconds ranges) by Potter & Brumfield Inc., Type 700 HT by Allen-Bradley Canada Ltd.

.4 Spares: Two spare relays and two spare sockets of each type in each panel.

2.9 Starters and Contractors

.1 Motor starters: Combination type, magnetic, full voltage, reduced voltage or multi-speed type, reversing or non-reversing, CSA Size 1 minimum, rated for system fault capacity [as indicated]. Intermediate CSA sizes not acceptable. By Allen-Bradley Canada Ltd., Siemens Electric Ltd., Westinghouse Canada, Square 'D' Canada.

.2 Overload relays: Adjustable, manually resettable, one element for each ungrounded phase conductor.

.3 Overload relay heaters: Field installed, selected to protect installed motor.

.4 Contactor: Electrically drawn in and held.

.5 Reversing starters: Contactors mechanically and electrically interlocked.

.6 Circuit breaker: Moulded case design, adjustable magnetic only trips coordinated with thermal overload device.

.7 Auxiliary contacts: Minimum one spare normally open and one spare normally closed, 120 V AC, 10 A contacts, separate poles.

.8 Heating and lighting contactors: Similar to motor starters, but without thermal overload devices. Circuit breaker with integral thermal magnetic trips, interrupting rating 18,000 A RMS symmetrical minimum at 600 V.

2.10 Insulating Barriers

.1 Barriers: Covering exposed terminals and terminal blocks against inadvertent contact.

.2 Warning labels: Lamacoid with 3 mm white letters on red background, on front of compartments where multiple power sources are present.

2.11 Internal Wiring

.1 Wiring type: Except shielded instrumentation wiring, copper, 600 V, single conductor, seven strands minimum, heat and flame-retardant type, TEW insulation. #16 AWG minimum for control circuits and #12 AWG minimum for power circuits.

.2 Wiring devices on hinged doors or panels: Extra flexible, forty-nine strands minimum, harnessed with nylon cable ties.

.3 Wiring terminations: On terminal blocks. Splices and soldered connections are not permitted. Brace and support wiring.

.4 Maximum number of conductors under one terminal: Two.

.5 Wire markers: Identify wiring at ends with slip-on type markers, Shur-Code by Thomas & Betts Ltd., Z-Type by Wieland Electric Ltd.

.6 Incoming cable supports: Clamp type.

.7 Separation: Keep AC and DC conductors separate and do not group together in same wire duct or harness. In addition, separate DC conductors into low level and high level signal conductors. Supply separate wiring ducts for 120 V AC signals.

3. EXECUTION

3.1 Installation

.1 Wrap panels in heavy duty plastic during construction. Protect against damage and moisture.

.2 Provide control panels where indicated.

.3 Assemble and erect floor mounted panels on channel bases. Install on 50 mm high concrete housekeeping pads.

.4 Provide wall mounted panels with 6 mm nylon or lead spacers.

.5 Install channel mounted panels on aluminum channels and fasten with stainless steel hardware. Use stainless steel anchor bolts for fastening channels to floor or parapet.

END OF SECTION

1. GENERAL

1.1 Requirements of Work

.1 Supply, install, Verify Performance, provide Commissioning assistance, and provide warranty for a complete and fully documented I&C system as shown on the Drawings and specified herein. The I&C system will form a subsystem of the overall WTP control system and contains City supplied equipment and Vendor Packages as specified in this and other Sections of the Specification.

.2 Component subsystems of the I&C system will include, but are not limited to, the following:

.1 Primary elements and transmitters

.2 Final control elements

.3 I&C field devices

.4 I&C junction boxes, local control panels, and marshalling panels

.5 Instrumentation cabling

.6 Instrumentation power supplies

.7 Conduit and cable tray

.8 PLC based control system

.9 Analyzer and transmitter manufacturer's configuration and programming software

.3 The Contractor's responsibility also includes receiving, un-crating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring, and testing of City supplied equipment and Vendor Packages.

.4 Where packaged, stand-alone control systems are supplied under other Divisions of this Specification, provide cabling to connect to the required remote monitoring and/or controllers. Provide end-to-end Performance Verification of all required remote monitoring and/or controllers. Ensure the correct functionality of any equipment supplied under Divisions 11 and 16.

.5 Documentation provided by the Contractor shall include as a minimum:

.1 Equipment descriptive data.

.2 Equipment installation instructions, service manuals, O&M manuals, bills of materials, and recommended spare parts lists.

.3 Schematics and interconnection wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.

.4 Records of conductor identification, field terminals, cable lists, changes, etc.

.5 I&C panel Shop Drawings, face layouts, schematics, and point-to-point wiring diagrams sealed by a Professional Engineer registered in the Province of Manitoba.

.6 Records of as-built information for the complete instrumentation system.

.7 For the PLC based control system, the Contractor shall provide detailed documentation of the system hardware.

.6 Documentation provided by the Contractor shall be formatted as follows:

.1 P&IDs – Depict the general intent of the control systems and are to be used as the governing document for the scope of Work.

.2 Instrument Index – A sorted index of the detailed information for the devices shown on the P&IDs. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials.

.3 I/O Index – A sorted index of the control system I/O points shown on the P&IDs, giving the supporting documentation as per the instrument index.

.4 Instrument Specification Sheets – Detail the relevant data for the supply of devices.

.5 Instrument Loop Diagrams – Show typical interconnections and hook-up of devices. The Contractor is to produce an instrument loop diagram for each device and record all relevant information on each sheet for submission at the completion of the Work. Fill in all terminal and wiring numbers etc. from the Shop Drawings as they become available. A set of 'B' size (11" x 17") AutoCAD drawings and associated files will be made available to the Contractor.

.6 Location Drawings – Indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the Contractor in estimating the amount of cable and ducting required.

.7 Standard Details – Provide a reference for installation, operation, and other instructions pertinent to a particular device.

.8 Detailed Specification – Lists qualifications, quality of materials and workmanship, and supplementary information.

.7 References

.1 This Specification contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section prevail.

Reference	Title
API RP550-86	Manual on Installation of Refinery Instruments and Control Systems, Part I – Process Instrumentation and Control Section one (1) through thirteen (13)
ASME Section VII-89	Rules for Construction of Pressure Vessels
ASTM B68-86	Seamless Copper Tube
ASTM D883-89	Terms Relating to Plastics
IEEE 100-88	Dictionary of Electrical and Electronic Terms
ISA RP7.1-56	Pneumatic Control circuit Pressure Test
ISA S5.4-76	Instrument Loop Diagrams
ISA S18.1-79	Annunciator Sequences and Specifications
ISA S51.1-79	Process Instrumentation Terminology
NEMA 250-85	Enclosures for Industrial Controls and Systems
NEMA ICS 1-88	General Standards for Industrial Controls and Systems
NEMA ICS 2-88	Industrial Control Devices, Controllers, and Assemblies
NFPA 70-90	National Electrical Code
SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UBC-88	Uniform Building Code
UL 1012-89	Power Supplies
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
Weik, Martin H.	Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983

.8 Related Work

.1 Process: Division 11

.2 Mechanical: Division 15

.3 Electrical: Division 16

.9 Codes, Rules, Permits and Fees

.1 Give all required notices, submit Drawings, obtain all permits, licenses, and certificates, and pay all fees required for this Work.

.2 Furnish a certificate of final inspection and approvals from inspection authorities to the Contract Administrator.

.10 Qualifications

.1 The instrumentation Subcontractor shall be a firm normally engaged and fully competent in the type of Work described in this Section of the Specification. The firm shall have been continuously and successfully engaged in this business for at least five (5) years.

.2 Qualified journeyman instrument mechanics that are familiar with the devices being installed shall perform all instrument hook-ups, calibrations, and checkouts.

.3 Qualified journeyman electricians shall perform all control wiring installation and connections.

.11 Standards of Workmanship

.1 Execute all Work in a manner which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this Specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.

.3 Arrange and install products to fit properly into designated building spaces.

.4 Install products in accordance with the recommendations and ratings of the product Manufacturers.

.5 Supply and execute installation of all instrumentation control tubing in accordance with Section 17140 – Instrument Air Supply and Transmission.

.12 Contract Drawings and Specifications

.1 Supply and install all items and accessories specified by the Drawings or the Specification in the quality and quantity required. Perform all operations as designated by the Specifications according to the methods prescribed, complete with all necessary labour and incidentals.

.2 Treat any item or subject omitted from this Division's Specifications or Drawings, but which is mentioned or reasonably specified in other Divisions' Specifications or Drawings and pertains to the I&C system, as being integral to the overall system. Supply and install such specified items or subjects.

.3 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.

.4 The responsibility to determine which Division provides various products and work is specified in Part D. Additional compensation will not be considered because of differences in interpretation of Specifications.

1.2 Equipment

.1 Indicate the type and make of all equipment and materials proposed for this project on the instrument index provided in Section 17700 – Instrument Index within forty (40) Business Days of award of Contract.

.2 Receiving, storing, and protection of components during construction:

.1 Examine each component upon delivery to Site. Report all damage noted to the Contract Administrator prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 10°C and the space relative humidity below 50%.

.2 Perform a preliminary examination upon delivery to ensure that:

.1 All I&C components supplied for this project under this Section of the Specifications comply with the requirements stated in the instrument specification sheets.

.2 All I&C components supplied under other Sections of these Specifications, to be connected to I&C components supplied under this Section of the specifications, comply with the requirements stated in the Contract Documents.

.3 Itemize all non-conformities noted above and forward them to the Contract Administrator. Any delays in construction resulting from the delivery to Site of non-conforming I&C components shall be borne by the Contractor.

.4 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.

.5 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.

.3 Take all necessary precautions to ensure that equipment is supplied free of damage. If deemed necessary by the Contract Administrator, damaged equipment shall be replaced with new product at no additional cost to the City. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

1.3 Site

.1 Classification of Plant Areas

.1 Refer to Division 16

1.4 Documentation

.1 Submittals

.1 Submit Shop Drawings for all products supplied by this Division. Submit Shop Drawings for review prior to purchase of any products or equipment and sufficiently in advance to allow ample time for checking.

.2 Contractor to review, modify, and approve the Shop Drawings prior to submitting Shop Drawings to the Contract Administrator for review. Contractor approval of a Drawing indicates the following:

.1 The Drawing has been checked by the person making the approval.

.2 The equipment or material complies in all respects with the requirements of the Specifications and Drawings.

.3 The quantities indicated are correct.

.4 The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment.

.5 The points of attachment are clearly indicated, i.e. TOP, BOTTOM, SIDE, etc.

.6 The arrangement and location are properly oriented.

.7 The product is suitable for its intended use.

.8 The submission consists of sufficient information to adequately convey the scope of supply and the specific product to be supplied is highlighted.

.9 The submission contains sufficient information to install the equipment or systems.

.3 Stamp and sign the Shop Drawing to show approval, indicating the above has been complied with. If Contractor revisions are too extensive, return the submission to the Manufacturer for revision, then repeat the Shop Drawing approval process before submitting to the Contract Administrator.

.4 Manufacture of products shall conform to Shop Drawings marked as reviewed by the Contract Administrator and returned to the Contractor.

.5 Keep one (1) complete, maintained set of Shop Drawings at the Job Site during the construction period. Record modifications and changes as they arise during the construction period and incorporate these changes in the Record Drawings.

.6 Refer to Division 1 for further information on Shop Drawing submittals.

.2 O&M Manuals

.1 Refer to Division 1 for general O&M manual submittal information.

.2 In addition to the requirements specified in Division 1, provide the following information:

.1 Table of Contents – Arrange contents sequentially by systems under section numbers. Label tabs of dividers between each to match section numbers in the Table of Contents.

.2 Systems Descriptions – A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.3 O&M instructions of all equipment and controls – These operating instructions need not be Manufacturer's data but may be typewritten instructions in simple language to guide the City in the proper O&M of this installation.

.4 A copy of all wiring diagrams complete with wiring coding.

.5 Include type and accuracy of instruments used.

.6 Set of final reviewed Shop Drawings.

.7 Provide a tabulated list of all consumables utilized (fuses, lamps, etc.) indicating where used, type, rating and reorder details.

.3 Record Drawings

.1 Maintain On-Site a complete set of Record Drawings.

.2 In addition to the requirements stated in Part E10, record the following information on the Drawings:

.1 all changes alterations or additions

.2 all instrumentation cable and control tubing

.3 all changes to the numbers and location of outlets, motors, panels and end devices that may occur during the course of the Work.

.3 Before requesting the Certificate of Total Performance, make any necessary final corrections to the Record Drawings, sign each print as a certification of accuracy and deliver all sets to the Contract Administrator for approval.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1**.**

.2 Selected Products:

.1 The design have been based on the use of the first named product where multiple products have been listed.

.2 The instrument Manufacturer's listed within this Division have been compiled into the list of approved instrument Manufacturer's that is included in the Appendices. Please refer to Division 11 for process specific analyzers not included in this list.

.3 Quality of Products

.1 All products provided to be CSA and ULC approved where applicable.

.2 If products specified are not CSA approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Refer to Division 1 of this specification for further information.

.4 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specification, uniformity of manufacture to be maintained for similar products throughout the Work.

.5 Product Finishes

.1 Contractor to specify proposed finishes to be used for Contract Administrator's review.

.6 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator. Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

2.2 Instrumentation

.1 General

.1 Instruments are to be suitable for the environmental conditions in which they are to be installed.

.2 Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.

.3 Provide power surge protection, heating cables, and devices to protect instruments, equipment, and lines from being functionally impaired or damaged by power surges or environmental conditions such as moisture or freezing.

2.3 Identification

.1 Refer to Division 16 for general identification requirements. Provide lamacoid nameplates with 6 mm black lettering on white background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.

.2 Where it is not possible to attach a lamacoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.

.3 Identify all wires where they terminate at the marshalling panels, junction boxes, control panels, and field devices with a heat shrink sleeve with machine printed labelling.

.4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.

.5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.

.6 Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a room, and 13 m on centre throughout the room. This shall apply to conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels for conduit identification.

.7 For direct current wiring use black for positive and white for negative.

.8 For thermistor wiring to motors use red and blue coloured insulated wire.

3. EXECUTION

3.1 Coordination With Other Divisions

.1 Examine the Drawings and Specifications of all Divisions and become fully familiar with the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any

conflicting issues between Divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.

.2 Coordinate the Work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.

.3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to installation Work.

.4 Lay out the Work and equipment with due regard to architectural, structural, and mechanical features. Architectural and structural Drawings take precedence over electrical Drawings regarding locations of walls, doors, and equipment.

.5 Structural members shall not be cut without prior approval of the Contract Administrator.

.6 Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this Work.

3.2 Product Handling

.1 Use all means necessary to protect the products included in this Division before, during and after installation, and to protect products and installed Work of all other trades.

.2 Any damage to the products and/or installed Work shall be repaired or replaced to the approval of the Contract Administrator by the Contractor.

.3 Remove advertising labels from all products installed that have such labels attached. Identification or CSA labels are not to be removed.

.4 Remove dirt, rubbish, grease, etc. resulting from Work performed under this Division of the Contract from all surfaces.

3.3 Separation of Services

.1 Maintain separation between the electrical wiring system, piping, ductwork, and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

.2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and only if approved clips or hangers are used.

.3 Classifications of Circuits

.1 The circuit categorization shall of first priority follow Canadian Electrical Code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200 A) LV circuits.
	Harmonic-rich LV circuits.
	DC circuits: un-suppressed or above 50 V.
Noisy	Low current class two (2) circuits.
	Medium power pulsed or radio frequency circuits.
Indifferent	ELV digital status circuits.
	Intrinsically safe circuits.
	Telecommunications circuits.
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits).
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm).
Sensitive	Analogue signal circuits.
	Data communication circuits.
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors).

.4 Separation of Circuits

.1 This Section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.

.2 For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference.

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per CE Code.	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CE Code.	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of circuit types.	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

3.4 Wire and Cable

.1 Refer to Section 17124 – Instrumentation Cable.

3.5 Equipment Connections

.1 Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

.2 All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturer's equipment. Verify all control circuits with the Manufacturers of the equipment and make any corrections to the control wiring diagrams that may be required.

.3 Provide power disconnect terminals in marshalling panels for all devices and PLC I/O sourced from the panel. Provide local power disconnect switches for all 120 VAC power instruments. Mount adjacent the instrument.

.4 Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local water proof junction box.

3.6 Wiring to Equipment Supplied by Others

.1 Equipment supplied by others, that have external or field mount control devices, are to be installed, wired and Performance checked by this Division.

3.7 Access Panels

.1 Provide access panels where I&C system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners.

.2 In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 25 mm diameter blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.8 Instrument Mounting Stands

.1 Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminium or galvanized steel.

.2 Supply and install protective drip shields for any exterior stand-mounted instrumentation equipment. The drip shield is to extend 50 mm at the top and sides from the front face of the equipment. The drip shield is to be fabricated from aluminium.

3.9 Sealing of Wall and Floor Openings

.1 Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.

.2 Seal openings after all wiring entries have been completed.

.3 Sealing material shall be fire resistant and not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.

3.10 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall partitions and ceilings the ends shall be flush with the finish on both sides. For floors, the ends shall extend 100 mm above finished floor level.

.3 Fill the space between the sleeve and the conduit with fire stop material and caulk around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate the sleeves and position exactly prior to construction of the walls and floors.

.5 Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.11 Connections to Mechanical, Electrical and Existing Systems

.1 Refer to Division 16 for the required tie-in procedures.

3.12 Tagging Standards for Devices and Wiring

.1 Tag all devices, wires, and I/O using the assigned loop, equipment, or device tag name. Where tag naming and numbering is not specified, the Contract Administrator will provide naming and numbering that is consistent with the WTP naming conventions.

3.13 Testing of Instrumentation Loops

.1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.

.2 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.

.3 Check and simulate all alarms and shutdown functions.

.4 Verify the status of all points connected or accessible to the WTP control and monitoring system.

.5 Where applicable, test all tubing for leaks in compliance with the ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.6 Perform tests and record results on the test data forms that are included in this Section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.

.7 Sign and date all test reports. Submit the test reports to the Contract Administrator within five (5) Business Days of testing.

3.14 Calibration

.1 Instruments are to be factory pre-calibrated. Verify calibration after installation for all instruments installed under these Specifications. Provide a printed record of the factory calibration parameters for "smart" devices.

.2 Prior to calibration, completely program all "smart" transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device serial numbers against their assigned tag number.

.3 Instruments are to be set up and calibrated by an accredited instrument technician working under the approval of the instrument Manufacturer.

.4 Calibrate all instruments to an accuracy of 0.5% of full range, or to the manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5% is not achievable.

.5 Perform the following applicable calibration verification for each instrument and its associated signal conditioning equipment:

.1 Calibrate all inline flow meters by a draw-down test.

.2 Calibrate all density meters by lab samples.

.3 Calibrate all vacuum and pressure instruments by manometer or accurate test instrument and hand test pump.

.4 Calibrate gas detectors using standard gas samples.

.5 Calibrate temperature instruments against a standard lab thermometer.

.6 Online analyzers with known samples.

3.15 Test Forms

Form No.	Title
.1 ITR	Instrument Test Report.
.2 LCR	Loop Check Report.

INSTRUMENT TEST REPORT

SYSTEM: _____ _____

SERVICE: _____ TAG NO.: _____

LOCATION: _____ _____

MAKE: _____ MODEL: _____

SERIAL NO.: _____ CSA: _____

ELEMENT: _____ RANGE: _____

DESIGN SETTING/RANGE: _____ CONTACT TO: _____ ON: _____

SIGNAL IN: _____ OUT: _____ ASSOCIATED INSTRUMENT:_____

INSTRUMENT CONDITION: _____ CONFORM TO SPEC: _____

PROJECT NO: _____ DATA SHEET: _____

	TEST 1				TEST 2			
TEST METHOD								
	INPUT		**OUTPUT**		**INPUT**		**OUTPUT**	
PROCESS	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**	**INC.**	**DEC.**
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

TESTED BY: _____ CHECKED BY: _____

DATE: _____ DATE: _____

LOOP CHECK REPORT

☐ CHECKED OUT OK

☐ NOT APPLICABLE

☐ FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.								
LOOP NO. _____ SHEET NO. _____ P & I DWG. NO. _____									
INSTALLATION COMPLETE									
Primary Element.									
Impulse Lines.									
Block and Drain Valves.									
Air Supply/Filter/Reg.									
Wiring.									
Tracing/Insulation/Housing.									
Mounting and Location.									
PLC/SCADA I/O & Status.									
CALIBRATED									
Impulse Lines Press. Tested.									
LOOP CHECKED									
Element to Receiver.									
X Mtr. To Receiver.									
X Mtr./Trans. to Receiver.									
X Mtr./Trans. to Switches.									
Switches to Annunciator.									
Interlocking Circuit.									
Controller to Valve.									
Controller Action D or R.									

REMARKS:

READY FOR START-UP

Date: _____

Installed by: _____

Checked by: _____

3.16 Installation and Performance Testing

.1 Refer to the requirements of Division 1 for additional requirements.

.2 Inspections

.1 Provide two (2) weeks' written notice to the Contract Administrator prior to energizing any system to allow for inspection by the Contract Administrator of the following:

.1 Proper mounting.

.2 Proper connections.

.3 During Performance Verification, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges.

.4 Performance Verification of the I&C system is to include but not be limited to the following:

.1 Verify installation of components, wiring connections, and piping connections.

.2 Supervise wiring continuity and pipe leak tests.

.3 Verify instrument calibration and provide written reports.

.4 Function check and adjust the I&C equipment under operational conditions.

.5 Coordinate manufacturer’s service personnel as required for complete system testing.

.6 Instruct WTP personnel in correct method of I&C equipment operation.

.7 Direct WTP personnel at hand-over as to final adjustment of the system for correct operation of WTP.

.8 Ensure that the Manufacturer’s representatives cooperate to complete the Work of this Section.

.9 Verify signal levels and wiring connections to all I&C equipment.

.10 Coordinate and cooperate with City staff and the Contract Administrator during the Commissioning Period to commission the interface between the Plant SCADA and the PLC based control system.

3.17 Training

.1 Provide training, described in detail in Division 1, in the proper operation and maintenance of all control devices, control valves, and ancillary instrumentation described under this Division of the Specifications.

END OF SECTION

SCOPE OF INSTRUMENTATION AND CONTROL WORK

1. GENERAL

.1 Supply and installation all material, equipment, wiring and labour necessary for the installation of the systems detailed on the Drawings in accordance with the Specifications and the latest edition of the Canadian Electrical Code.

2. WORK INCLUDED

2.1 Related Work

.1 Supply and installation of instrumentation and control equipment required to operate the WTP including the plant control system PLC equipment and all vendor packages and City supplied equipment as indicated on the P&IDs.

2.2 General Requirements

.1 Shop Drawings

.2 Record Drawings

.3 O&M Data

2.3 Specific Requirements Included Within but not Limited to the Scope of Work

.1 Supply, install, test, and verify the performance of all instrumentation, components, materials and ancillary equipment covered under Division 17 of this Contract.

.2 Provide a fibre optic communication ring for the PLC based plant control system. Provide a fibre optic communication ring for the HMIs on the plant monitoring system.

.3 Provide fibre optic/CAT5 Ethernet switches with an allocation of spare RJ45 connection points equal to not less than 50% of the used capacity.

.4 Terminate all spare fibre optic cores to patch panels at each drop point and label accordingly.

.5 Provide local control panels to house all PLC components and ancillary equipment, and to act as a marshalling panel for signals from instrumentation and equipment covered under Division 17.

.6 Supply redundant 24 VDC Power supplies installed within the local control panels whenever 24 VDC power is required.

.7 Provide power conditioning equipment within each local control panel.

.8 Connect the healthy/fault status dry relay contacts from all power conditioning and UPS equipment to local PLC inputs.

.9 Provide Ethernet connections from the following equipment to the plant control system: VFDs, transformer power meters, neutral grounding resistors, switchgear protection relays, and large motor protection relays.

.10 Hardwire I/O signals from the plant control system PLCs to process instrumentation, HVAC/BMS system, Power Conditioning and UPS equipment and fire alarm panels.

.11 All plant control system PLC programming and plant monitoring system HMI software development shall be performed by others.

.12 Coordinate with Division 16 to connect CCTV camera equipment via fibre optic cabling to the monitoring equipment in the control room.

.13 Coordinate with Division 16 to connect the fire alarm panels in a fibre optic Ethernet based communication loop.

.14 Coordinate with Division 15 to connect the HVAC/BMS system in a BACNet based communication loop.

.15 Coordinate with the individual suppliers of equipment supplied under other contracts but installed under this contract to install, test and verify performance of the systems shown on the P&IDs.

2.4 Additional Requirements

.1 Provide all necessary testing, detailed wiring continuity checks, installation integrity checks, equipment functional operation checks, and written system verification reports to provide a complete system that is ready for commissioning and start-up.

.2 Provide Performance Verification and start-up of all systems included in the Scope of Work.

2.5 Materials

.1 Cables and bus support systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems.

.2 Control panels associated with any electrical equipment covered under this Section of Work.

.3 Circuit breakers of all types and for all applications associated with electrical equipment, which receives its power supply from the main, auxiliary or emergency (including UPS) system.

.4 Grounding systems, as required by the Canadian Electrical Code, or as otherwise specified.

.5 Fibre optic patch panels and industrial Ethernet switches as shown on the Drawings and specified herein.

.6 Electronic data processing and transmission systems, including auxiliary equipment, interfaces and components.

END OF SECTION

ENCLOSURES

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 General

.1 Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey as specified in Division 9.

.2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

2.2 Enclosures

.1 Provide EEEMAC type 12 gasketted enclosures in MCC rooms and control rooms.

.2 All enclosures for mounting outside of MCC rooms and control rooms to be EEMAC Type 4, watertight except where otherwise specified.

.3 Provide EEMAC 7/3R enclosures for equipment in and around classified areas such as sumps.

.4 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).

.5 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.

.6 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

2.3 Panel Enclosures

.1 Fabricate panel enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing lineup. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.

.2 Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.

.3 Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120 VAC duplex convenience receptacle inside the enclosure.

2.4 Marshaling and Control Panels

.1 Supply, fabricate, checkout, layout, document and deliver to Site fully equipped and functional panels.

.2 Supply all components contained on or within the panels fully wired under this Section of the Specification.

.3 The selection of all accessories, materials, and methods for fabrication not covered by this Specification, but which are necessary to complete the fabrication of the control panels, is the responsibility of the Contractor.

.4 Fans and filters shall be installed to pressurize all control panels thus discouraging dust accumulation and providing air purging for temperature and corrosion control.

.5 Control panel layouts and wiring diagrams are to be provided by the Contractor as Shop Drawings.

2.5 Wiring and Accessories

.1 Provide wiring inside the panels according to the following Specifications:

.1 Control wiring to be a minimum of #16 AWG tinned stranded copper; insulation rated at 600 V.

.2 Wiring for power distribution shall be a minimum of #14 AWG tinned stranded copper; insulation rated at 600 V.

.3 Install cables in accordance with the requirements of Division 16.

.2 Tag each wire at both ends with a heat shrink sleeve that is machine printed. Allow approximately 20 mm of wire insulation between the tag and the bare wire.

.3 Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes.

.4 Run all wiring in enclosed plastic wire ways such as Panduit. Size all wire ways so that the total cross sectional area of the insulated wire and cable does not exceed 40% of the cross sectional area of the wire way.

.5 Provide a minimum clearance of 50 mm between wire ways and any point of wire termination.

.6 Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:

ENCLOSURES

.1 Wire identification to use the connected field device tag name with the wire's corresponding end device terminal number appended to it.

.2 Identify every joint and/or terminal of the above wire run with the same identifier.

.3 For example, pressure transmitter PT-O100A located in the field has a 1 PR-TPSH cable connected to it. The cable runs through a junction box to a marshaling panel. The wire identifiers for the pair of wires would be PT-O100A all the way to the marshaling panel.

.4 Identify spare wires by using the cable tag, terminal number and an "-SP" suffix.

.5 Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wiring terminates on the outboard side.

.7 Provide two sources of 120 VAC power to each control panel: UPS power for critical loads and non-UPS power for non-critical loads. Provide separate critical and non-critical 120 VAC power distribution systems and a 24 VDC power distribution system in each panel. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block for each branched circuit off the main.

.8 Provide disconnect type terminal blocks Weidmuller WTR 4 series to isolate field wiring that is powered sourced from the panel. Provide a dedicated fused disconnect type terminal block to isolate each individual PLC input and output.

.9 Provide sufficient terminals so that not more than two (2) wires are connected under the same terminal. Provide 20% spare terminal capacity at each terminal block assembly.

.10 Terminals shall be Weidmuller W Series color coded as follows:

.1	Red	=	positive 24 VDC
.2	Black	=	analog signal plus
.3	White	=	analog signal common and VAC neutral
.4	Grey	=	120 VAC
.5	Green	=	ground
.6	Yellow	=	shield

.11 Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be white lamacoid with black lettering, a minimum of 25 x 75 mm in size with up to three lines of 5 mm lettering. Securely fasten nameplates in and situate them in a visible location.

2.6 Panel Grounding

.1 Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.

.2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

.3 Provide in each marshaling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two #2 AWG grounding conductors.

.4 Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010 – Instrumentation and Control General Requirements, Part 3.

3.2 Mounting Heights

.1 Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 2000 mm to top of cover.

END OF SECTION

INSTRUMENTATION CABLE

1. GENERAL

1.1 Product Data

.1 Submit product data in accordance with Division 1 and Division 16.

1.2 Related Work

.1 Refer to Division 16.

1.3 Inspection

.1 Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to energizing equipment.

1.4 Standards

.1 All wire and cable shall be CSA approved.

2. PRODUCTS

2.1 TPSH

.1 TPSH shall be constructed as follows:

.1 Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm.

.2 Insulated for 600 V, 90°C.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire, minimum #18 AWG.

.5 Overall flame retardant PVC jacket to CSA-C22.2.

.6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

.7 Shaw Type 1751-CSA or Belden equivalent.

.2 Where multi-conductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.2 RTDs and Multi Conductor Shielded Cable

.1 RTD cables shall be CSA approved and shall be constructed as follows:

.1 3 or more copper conductors, stranded, minimum #18 AWG.

.2 PVC insulated for 600 V.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire.

.5 Overall flame retardant PVC jacket to CAS-C22.2.

2.3 Teck Cables

.1 As per Division 16.

2.4 Wire

.1 As per Division 16.

2.5 100 Base TX Category 5E Communication Cable

.1 Category 5E cable shall be CSA approved and constructed as follows:

.1 4 pairs, solid stranded, #24 AWG

.2 PVC inner and outer jackets

.3 UL verified to Category 5E

.4 Insulated for 300 V

2.6 Fibre Optic Cables

.1 Provide break out style fibre optic cable assemblies where indicated in the Specification and Drawings.

.2 Fibre optic cables shall be indoor/outdoor direct burial rated loose tube, rodent protected and constructed with specified quantity of 62.5/125 µm multi-mode glass fibres, spiral interlocked armour, and outer polyethylene jacket. Maximum attenuation shall be 3.5/1.0 dB/km. Minimum modal bandwidth shall be 220 MHz*km

.3 Provide terminations for fibre optic cables including; buffer tube fan out kits, connectors, termination/distribution panels, and wall mount enclosures.

.4 Provide 62.5/125 µm multi-mode duplex fiber patch cords for inter-cabinet connections.

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH cable for all low level analog signals such as 4 to 20 mA, pulse type circuits 24 VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTDs and transmitters or PLC RTD inputs.

3.2 Digital Signals

.1 Use TPSH cable for all low level (24 V and below) input and output signals.

3.3 Instrument Power

.1 Use Teck cable or wire and conduit for power to instruments, for 120 V signals other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

3.4 Installation

.1 Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm and a maximum of 1000 mm length of liquid tight flexible conduit to connect the field sensors to the conduit.

.2 Where non-armored instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.

.3 At each end of the run leave sufficient cable length for termination.

.4 Do not make splices in any of the instrumentation cable runs.

.5 Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

.6 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

.7 Protect all conductors against moisture during and after installation.

.8 Fiber Installation:

.1 Always follow the Manufacturer's guidelines for minimum bend radius and tension. Minimum bend radius shall be a minimum of 20 times the cable diameter

.2 When installing loose-tube cables, use a silicone injection or sealer to prevent gel migration.

.3 All fibre installations and terminations shall be performed by an experienced fibre optic cable installation contractor.

3.5 Conductor Terminations

.1 All equipment supplied shall be equipped with terminal blocks to accept conductor connections.

.2 Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

.3 Fiber Terminations:

.1 Ensure that the fibres are not damaged when the buffer tubes and fibre coatings are removed.

.2 After the coating is removed, clean the fibre with isopropyl alcohol to assure the fibre is clean.

.3 Use only high performance connectors as classified and required by TIA-568-A.

3.6 Testing

.1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable Manufacturer.

3.7 Identification

.1 Identify all instrumentation cables.

.2 Identify each conductor with wire numbers using a machine printed Raychem TMS heat shrink wire marker or approved equal.

END OF SECTION

POWER SUPPLIES

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Power Supply and Conditioning Equipment

.1 General

.1 Provide all DC power supplies as required for all instrument circuits. All circuits are to be powered from the marshalling panels. Power supplies to be Hammond, G.F.C. or approved equal, complete with an over-voltage protection module.

.2 Provide redundant configurations for power supply equipment serving more than one instrument loop, so that failure of a single unit will not disable all or any shared part of the instrumentation and communication system. Provide diode isolation for redundant direct current supply units, and ground the negative terminal of the power supply. In accordance with Section 17110 – Enclosures, a dedicated thermal magnetic circuit breaker shall feed each power supply.

.3 Power supplies and transmitters feeding circuits that run in non-armored cable in cable tray shall meet the requirements for Class 2 circuits as defined under Section 16 of the Canadian Electrical Code Part I.

.4 Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable plus or minus 5%, and set to provide 26.4 V on the panel direct current bus. Size the power supply for 2 times the connected load, minimum size is 2 amps.

2.2 Noise Suppression

.1 Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX.

2.3 UPS Power Supply

.1 Provide two sources of 120 VAC power each control panel: UPS power for critical loads and non-UPS power for non-critical loads.

.2 Control and operator interface system hardware including but not limited to PLCs, PLC I/O racks, PLC communication modules, HMI computers and industrial network switches shall be powered from the UPS.

.3 Instrument power and associated DC power supplies shall be powered from the UPS.

.4 Non-critical loads include control panel interior lights and receptacles.

.5 Online double conversion UPS' shall be provided in each electrical and server room as specified in Division 16. Coordinate with Division 16 to ensure that the plant's UPS' are of sufficient size to power the critical loads that are fed from each control panel.

.6 Mount a lamacoid on the control panel stating that the panel has more than one power source.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

INSTRUMENT AIR SUPPLY AND TRANSMISSION

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Pneumatic and Process Connections

.1 Pipe, fittings, valves, tubing, tube fittings, etc. required under this Section of the Contract to be Swagelok or approved equal and rated for the service in which they are to be employed. Tubing and fittings are to be made of stainless steel.

.2 Dimensions:

.1 Process connections 12 mm (nominal) O.D. tubing

.2 Output/signal - 10 mm (nominal) O.D. tubing

.3 Air supply 12 mm pipe (nominal) to isolation valves and 10 mm O.D. tubing (nominal) from isolation valves to end devices (e.g. valves).

.3 Provide a continuous support channel or raceway for all tubing.

2.2 Air Sets

.1 Provide all pneumatic actuator assemblies with an air set.

.2 Provide Fischer 67FR air sets unless specified otherwise in the Instrument Specification Sheets of Section 17701 – Instrumentation Specification Sheets.

.3 Air set to be complete with filter regulator and output gauge.

2.3 Solenoid Valves

.1 Provide ASCO Redhat type solenoid valves unless specified otherwise in Division 11 or on the Instrument Specification Sheets of Section 17701 – Instrumentation Specification Sheets.

.2 Solenoid enclosures to be minimum EEMAC 4; corrosive areas require EEMAC 4X and hazardous areas require EEMAC Type 9. Refer to Division 16 for area classifications.

.3 Provide manual overrides on coils when solenoid is used to actuate a valve.

.4 Standard coil voltage: 120 VAC.

.5 Pipe size: 3-way valve – 6 mm; 4-way valve – 10 mm.

.6 Maximum operating pressure: 850 kPa instrument air.

.7 Minimum operating pressure: 20 kPa instrument air.

3. EXECUTION

3.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

3.2 Tubing and Fitting Installation

.1 Group instruments logically together. Orient instrument air and process connection isolation valves to provide consistent handle indication of normal open/closed status.

.2 Final location of skid mounted instruments to provide sufficient clearance for access to all maintenance settings, to provide unobstructed viewing of instrument indicators and to permit instrument calibration and maintenance during normal operation of the Site.

.3 Tubing installations shall slope down 20 mm per 2 m of run to process connections.

.4 Support tubing in channel or raceway if exposed or in close proximity to rotating equipment or high traffic areas. Otherwise, do not exceed 1 m between tubing supports.

.5 All turns shall have a minimum bending radius of 50 mm.

.6 Avoid non-terminal connections in tubing runs.

.7 Use teflon tape on all threaded fittings. Do not apply tape on the first two threads.

.8 Tubing shall terminate at devices with fittings or 90° bends so as to allow removal of tubing without disturbing the device mounting.

.9 Complete the final 300 mm (nominal) of air tubing to instruments or control valves installed in process equipment with flexible reinforced neoprene hose. Support the tubing at the hose connection. Locate the hose connection to facilitate unrestricted removal of the instrument or control valve and to minimize transmission of process equipment vibration into the tubing.

END OF SECTION

PROCESS TAPS AND PRIMARY ELEMENTS

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Process Taps

.1 Supply pressure gauge and thermowell taps. Products shall be as specified in Division 15.

2.2 Primary Elements

.1 Supply and install primary elements and transmitters as specified on the Instrumentation Specification Sheets of Section 17701 – Instrumentation Specification Sheets.

.2 Supply written assurance that the instrument Manufacturer approves the selection for the primary element materials that are in contact with the specified process fluid and certifies that the materials are inert to the effects of the process fluid.

.3 Supply and install drip pots for sensing elements measuring gas. Supply seamless, stainless steel drip pots consisting of a 50 x 300 mm pipe with an isolating valve and a drain valve. Install a separate drip pot on each sensing line. Locate the drain valve within 500 mm of the floor.

.4 Supply diaphragm seals for any fluid other than water or glycol.

.5 When diaphragm seals are specified with a pressure gauge or a pressure switch provide the assembly filled with ethylene glycol and calibrated by the Manufacturer.

.6 Supply and install an ethylene glycol filled assembly calibrated by the manufacturer when in-line pressure sensors are specified with a pressure gauge or a pressure switch or in combination.

3. EXECUTION (NOT USED)

END OF SECTION

TRANSMITTERS AND INDICATORS

1. GENERAL

1.1 References - General

.1 Equipment, products and execution must meet all requirements detailed in Section 17010 – Instrumentation and Controls General Requirements.

2. PRODUCTS

2.1 Transmitters and Indicators

.1 Supply and install transmitters and indicators as specified on the Instrument Specification Sheets of Section 17701 – Instrument Specification Sheets.

.2 Transmitters shall have adequate power output to drive all devices associated with the signal loop. Provide signal boosters as required to achieve adequate signal strength or to isolate the signal. Provide current-to-current signal isolators for all secondary devices in the control loop.

.3 All transmitters to have local indication scaled in engineering units as specified in the engineering Specifications. Provide a lamicoid label indicating the calibrated range and engineering units and mount adjacent to the transmitter. Mount the transmitter so the indicator is visible by operations personnel.

.4 Remote indicators provided by Crompton Instruments, Simpson, or Newport are acceptable for use.

.5 Where the loop specification calls for a transmitter and an indicator to be mounted in the same panel, an indicating transmitter may be considered acceptable, provided the indicator is normally visible from outside the enclosure.

.6 Where available as an option, the transmitter shall be supplied with an isolated fault contact.

.7 Standard of acceptance for instrumentation shall be as follows:

.1 Magnetic Flow Transmitters: Rosemount 8700 Series, ABB Magmaster, Krohne, Endress and Hauser.

.2 Thermal Mass Flow Transmitters: ABB, Brooks.

.3 Variable area Flow Transmitters: Omega, Kobold

.4 Pressure Transmitters: Rosemount Model 3051, ABB or Foxboro complete with stainless steel two (2) and three (3) valve manifolds as manufactured by Anderson Greenwood.

.5 Pressure Gauges: Ashcroft, H.O. Trerice, Budenberg.

.6 Ultrasonic Level Transmitters: Siemens Multiranger 100/200, Magnetrol, Endress & Hauser.

.7 Radar Level Transmitters: Endress & Hauser, Siemens, Magnetrol.

.8 Magnetic Level Indication: Krohne, Magnetrol, K-Tek KM26.

.9 Sludge Blanket Level: Partech, Hach, Siemens, Cerlic.

.10 Temperature Transmitters (RTD): Rosemount, ABB, Foxboro.

.11 pH Sensors: Rosemount, Endress and Hauser, ABB, Foxboro 870 Series.

.12 Turbidity Sensors: Hach, Rosemount, Endress and Hauser, GLI.

.13 Chlorine Residual Analyzers: Wallace & Tiernan Micro/2000, Hach, Rosemount, Endress and Hauser.

.14 Chloramination/Monochloramine Analyzers: Chemscan, Hach.

.15 Ammonia Analyzers: Hach, Waltron, ATi.

.16 DO Sensors: GLI International, Royce Instruments, Capital Controls.

.17 Ozone Analyzer: Crowcon.

.18 Dew/Moisture Measurement: Veronics.

.19 Particle Counter Analyzer: Hach, Chemtrac.

.20 Suspended Solids Analyzer: Hach, Cerlic.

.21 Power Meters: Power Measurement Limited (PML).

.22 Gas Detection Systems: Draeger, MSA, Crowcon.

3. EXECUTION

3.1 References - General

.1 Refer to Section 17010 – Instrumentation and Controls General Requirements.

END OF SECTION

SWITCHES AND RELAYS

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 General

.1 Use normally closed contacts for alarm actuation. The contacts open to initiate the alarm.

.2 Use normally open contacts to control equipment. The contacts close to start the equipment.

.3 Contacts monitored by solid state equipment to be hermetically sealed and adequately rated for the connected load.

.4 Contacts monitored by electro-magnetic devices such as mechanical relays to be rated NEMA ICS 2, designation B300.

.5 Provide double barriers between switch elements and process fluids such that failure of one (1) barrier will not permit process fluids into electrical enclosures.

.6 Switch electrical enclosures to be rated EEMAC 4X, minimum.

.7 120 VAC switches to have a 4A rating.

2.2 Indicators, Pushbuttons, and Selector Switches

.1 All control indicator lamps, pushbutton switches and selector switches in unclassified or non-corrosive areas to be Allen Bradley 800T or 800E series items or Cutler Hammer 10250T series.

.2 All control indicator lamps, pushbutton switches, and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series items or Cutler Hammer E34 series.

.3 Enclosures to be specified under Section 17110 – Enclosures.

.4 All control indicator lamps shall be push-to-test type.

2.3 Relays

.1 The quality and type of relays shall be based on Omron relays. Other acceptable manufacturers are Idec and Potter & Brumfield.

.2 120 VAC relays to be Model LY 4PDT, plug-in, complete with test button and operation indicator, and surge suppressor.

.3 24 VDC relays to be Model MY 2PDT plug-in, complete with test button and operation indicator, and surge suppressor diode.

.4 Time delay relays for behind panel mounting to be Omron Model H3BA, 2PDT, plug-in, and programmable for sixteen (16) time ranges and four (4) operation modes.

.5 Time delay relays for flush panel mounting and operator accessible timing range modifications to be Omron Model H5BR, SPDT, screw terminals, programmable for five (5) timing ranges and eight (8) operation modes, complete with digital display, module for time settings and flexible protective cover.

.6 Where the contact ratings of the relays listed are insufficient for the application, select an appropriate type from an approved Manufacturer with the same quantity of contacts as was originally specified.

.7 Provide relay plug-in sockets for DIN mounting complete with stacked screw clamp terminals.

2.4 Process Switches

.1 Standard of acceptance for instrumentation shall be as follows:

.1 Thermal Flow Switches: Ifm, Weber.

.2 Pressure Switches (Electronic): Ifm, United Electric.

.3 Pressure Switches (Conventional): Ashcroft, United Electric, Barksdale.

.4 Conductivity Level Switches: Endress & Hauser.

.5 Vibration Type Level Switches: Endress & Hauser.

.6 Float Switches: Flygt, Consolidated Electric, Warwick, Magnetrol.

.7 Capacitance Level Switches: Siemens, Endress & Hauser.

.8 Admittance Level Switches: Magnetrol, Bestobell.

.9 Temperature Switches: Ifm.

3. EXECUTION

3.1 References – General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

END OF SECTION

SIGNAL CONDITIONING MODULES

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Signal Conditioning Modules

.1 Where required, supply and install signal conditioning modules that comply with the following requirements, unless otherwise specified:

.1 Analog signal inputs: 4 to 20 mA DC into 500 ohms.

.2 Analog signal outputs: 4 to 20 mA DC into 500 ohms.

.3 Discrete output contacts: SPDT rated 5A, 120 VAC.

.4 Arrange electronic trips so that output contact opens in case of loss of signal or loss of power supply.

.5 Modules to be rated for continuous operation in an ambient temperature of 0 to 80°C. Ambient temperature effect not to exceed plus or minus 0.01% per °C within that range.

.6 Span and zero adjustments to be made by front accessible multi-turn potentiometers or keypad.

.7 Supply and install electronic trip modules with LED indicators for relay status.

.8 Modules to withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25% calibration effect. Provide modules with traps on the terminals to shunt conducted radio frequency interference to ground.

.9 Galvanically isolate signal and power supply terminals from the case.

.2 All modules specified in this Section to be the product of a single Manufacturer.

2.2 Current to Pneumatic (I/P) Converters

.1 Supply and install I/P converters where required, as indicated on the Drawings.

.2 Supply all required hardware for mounting the I/P converter on the controlled device.

.3 I/P converter shall be of EEMAC 4 construction or as specified in the Instrument Specification Sheets.

.4 I/P converter to operate with instrument quality, control air at an operating pressure range of 20 to 200 kPa.

.5 Approved I/P converter manufacturers are Omega and Moore.

3. EXECUTION

3.1 References – General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

PANEL INSTRUMENTS

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Electronic Panel Instruments

.1 Supply and install panel instruments with the following requirements, unless otherwise specified:

.1 Analog instruments to be miniature-case draw-out type nominally 150 mm high by 75 mm wide by not more than 350 mm deep.

.2 Make the operator, tuning and configuration adjustments accessible without disconnecting the instrument from the process.

.3 Analog signal indicators to be solid state, LED or gas-discharge type, including bar-graph displays with not less than 200 segments. Backlit LCD indication is also acceptable.

.4 Analog signal inputs to be 4 to 20 mA VDC.

.5 Analog signal outputs to be 4 to 20 mA VDC into 500 ohms.

.6 Galvanically isolate the signal and power supply from the instrument case.

.2 Panel instruments specified in this Section are to be the product of a single manufacturer, and to match and line up to form an integrated appearance and operator interface strategy. Approved manufacturers are Crompton Instruments and Simpson.

3. EXECUTION

3.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

END OF SECTION

MISCELLANEOUS PANEL DEVICES

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

2. PRODUCTS

2.1 Miscellaneous Panel Devices

.1 Pilot Lights

.1 Supply and install LED or transformer type pilot lights for extended lamp life, oil tight, push to test, complete with appropriate colour lenses. Normal colours used are run = red, stop = green. Refer to Division 16 for additional information.

.2 Terminals

.1 Supply and install strap screw type terminal blocks rated for 600 V.

.2 Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks are to be identified by the electrical ground symbol.

.3 Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors.

.4 Terminals to be Weidmuller or approved equal.

.5 Supply and install a group of terminals for each of 120 VAC non-UPS hot and neutral, 120 VAC UPS hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping.

.6 Supply and install Weidmuller disconnect type terminal blocks for each load or loop powered from the marshalling panels.

.3 Nameplates

.1 Refer to Section 17010 – Instrumentation and Control General Requirements for nameplate specification.

2.2 Signal Current Isolator

.1 Isolators shall be installed to provide galvanic isolation of milli-ampere transmission signals from transmitters with inadequately isolated output circuits.

.2 Isolator shall be housed in a NEMA 250, Type 4/7 conduit body and derive its operating power from the signal input circuit.

.3 Input and output signals shall be 4 to 20 mA, with an error not exceeding 0.1% of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.

.4 Approved manufacturers are Moore Industries, Weidmuller or Phoenix.

2.3 Intrinsic Safety Barriers and Relays

.1 Provide intrinsic safety barriers where required for two-wire transmitters of the active, isolating, loop powered type; MTL Type MT3042, Stahl 9005/01-252/100/00, Pepperl & Fuchs ZG series, or approved equal.

.2 Provide dual type intrinsic safety barriers for process switches; MTL 787, Panalarm 201-BR2.

.3 Intrinsic safety relays to be Gems or Warrick.

2.4 Industrial Ethernet Switches

.1 Install Ethernet Switches in separate panels mounted next to all control panels housing PLCs that interface to the WTP control and operator interface network as shown on the drawings. Connect to the PLCs, local HMIs, VFDs, power meters and motor protection relays as shown on the drawings using cable rated for 100 Base-TX communication.

.2 Switches shall comply with IEEE 802.3, 802.3u, 802.3x, 802.1D.

.3 Switches that are part of the plant control system communication ring or plant monitoring system communication ring shall include a minimum of 5 10/100 Base T(x) RJ45 Ports and 2 multimode 100 Base FX Fiber ports. Switches that only provide an interface between a PLC and local VFDs and motor protection relays shall include a minimum of 8 10/100 Base T(x) RJ45 Ports.

.4 Switches shall include one (1) relay output alarm contact rated for 1A@24 VDC.

.5 Input power shall be capable of ranging from 9 to 32 VDC with redundant inputs.

.6 Switches shall be fast spanning for a sub-second recovery in a ring configuration.

.7 Switches shall be Eagle Technology ED6008 Series, Schneider ConneXium Series or approved equal.

2.5 Fiber Termination Panel

.1 Install a fibre termination panel suitable for the termination of two (2) 12-strand multimode fiber optic cables in each panel that houses a fiber Ethernet switch and next to all control panels housing PLCs, PLC remote Input/Output (I/O) racks, or HMI that interface to the WTP control and operator interface networks.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

GAS DETECTION SYSTEMS

1. GENERAL

1.1 Description

.1 This Section specifies the supply, installation, testing and Performance Verification of gas detection systems.

.2 Use this Specification in conjunction with Section 17010 – Instrumentation and Control General Requirements.

1.2 Reference Standards

.1 Conform to the following reference standards in accordance with Division 1:

.1 CSA C22.2 No. 152, Combustible Gas Detection Instruments.

.2 Canadian Electrical Code, Part 1, CSA - C22.1

1.3 Shipping and Storage

.1 Ship and store equipment in accordance with the requirements of Division 1.

.2 Store gas detection instruments in their original shipping containers in a dry location that is free of fumes and vapors. Never store an instrument in an area where desensitizing agents (such as paint or silicone) may be present.

2. PRODUCTS

2.1 Function

.1 General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 2.

.2 Gas Detection Systems shall be from Draeger, MSA, or approved equal. Provide Infrared sensors for the detection of hydrocarbon based gases.

.2 Provide gas detection systems which include:

.1 Field mounted sensors/transmitters.

.2 Alarm beacons.

.3 Room entrance alarm panels.

.3 Provide field elements that are certified Class I, Division I.

2.2 Details

.1 The gas detection system will monitor for concentrations of:

.1 Combustible gas (gasoline vapours, etc) at low level sensor (LEL).

.2 Hydrogen.

.3 Ozone.

.2 Supply and install sensors and calibrators as specified on the Instrumentation Specification Sheets in Section 17701 – Instrumentation Specification Sheets.

.3 Supply and install combustible gas sensors with dual condulet and sensor guards to allow the sensors to be ceiling mounted and the sensor electronics to be at maintenance level. The sensor guard will be piped to the maintenance level with polypropylene. Refer to the Instrument Installation Details, Section 17704 – Instrument Standard Details.

.4 Alarm beacons will operate on 120 V, 60 Hz. Beacons mounted in the process area will be classified Class I, Division I. Beacons mounted outdoors will be EEMAC 4X.

.5 Power gas monitors from separate breakers located in a UPS powered panel board in the electrical room.

.6 Refer to the requirements of Section 17010 – Instrumentation and Control General Requirements for instrument and wiring identification.

.7 For catalytic bead type sensors, Provide 75 x 250 mm nameplates in sensor locations engraved "CAUTION: PAINT OR SILICONE COMPOUNDS WILL DAMAGE SENSOR".

2.3 Spare Parts/Tools

.1 Supply a calibration kit including a one year supply of all gases to calibrate all sensors and sensor types. The calibration kit must include, but not be limited to, all regulators and equipment required to perform regular On-Site calibrations.

3. EXECUTION

3.1 General

.1 Refer to the requirements of Section 17010 – Instrumentation and Control General Requirements, Part 3 for additional execution details.

3.2 Wiring

.1 Wire devices as shown on the installation details and the cabling diagrams.

.2 Wiring methods must comply with the area classification, CSA C22.2 No. 152 and the requirements of Division 16**.**

3.3 Field Testing and Inspection

.1 Refer to the requirements of **S**ection 17010 – Instrumentation and Control General Requirements, Part 3 for additional details.

.2 Provide an inspection of the gas detection system and all related components. The inspection will comprise of the following:

.1 That the system functions as intended including equipment shutdowns and startups, alarms, reset, calibration, etc.

.2 That all CSA requirements were adhered to when making wiring connections to all equipment components.

.3 That equipment has been installed in accordance with manufacturer's recommendations and that all signal devices have been operated or tested to verify their operation.

3.4 Performance Verification & Start-up

.1 Performance Verification and start-up shall be performed in accordance with CSA Standard C22.2 No. 152 and the requirements of Section 17010 – Instrumentation and Control General Requirements, Part 3.

3.5 Certification

.1 Inspection certification: on completion of the inspection and when all of the above conditions have been complied with, the Contract Administrator will be issued:

.1 A copy of the inspecting technician's report showing location of each device and certifying the test results of each device.

.2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.

3.6 Training

.1 Provide On-Site training in accordance with Division 1 and Section 17010 – Instrumentation and Control General Requirements.

END OF SECTION

PROGRAMMABLE LOGIC CONTROLLERS

1. GENERAL

1.1 References - General

.1 Equipment, products, and execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

1.2 Work Included

.1 Supply, and installation of a PLC-based control system that will control and monitor the system in accordance with the requirements specified on the drawings and the I/O lists.

.2 PLC's and I/O shall be housed in central control panels.

.3 PLC programming is not in the scope of this Contract.

.4 Start-up and commissioning assistance as required for the control system.

1.3 Related Work

.1 General Process Provisions: Division 11

2. PRODUCTS

2.1 PLCs

.1 General

.1 All new PLC equipment shall be based on the Modicon Unity Processor family.

.2 All PLC’s shall be Modicon Unity hot standby processors complete with standby processors.

.3 Communication protocol for the new PLC network shall be Modbus/TCP. Ethernet communication modules shall be provided in each PLC rack to interface to the plant control network.

.4 Supply and install all necessary racks, power supplies, cables, I/O cards, communication cards, and accessories.

.5 Supply spares of all PLC system components (minimum of ten (10) of each exact type with the exception of racks – supply two (2) of these) supplied including: power supplies, processors, communication modules, and input/output modules.

.6 Supply 10% spare slot capacity for each PLC panel assembly.

.7 Supply 25% spare power supply capacity for each PLC panel assembly.

.8 PLC racks shall be powered from the external UPS system. Each new PLC panel assembly shall include Sola Hevi-Duty STV100K series incoming power transient surge suppression or approved equal. Connect the surge suppressor dry contact to a PLC input and configure as an alarm on the control system at each panel.

.2 PLC

.1 Modicon Unity main processor and hot standby central processing unit (CPU): Model Number 140 CPU 671 60.

.2 Modicon NOE (Modbus/TCP) modules for each processor rack.

.3 Redundant cable remote I/O modules in each I/O rack: Model Numbers 140 CRP 932 00 and 140 CRA 932 00.

.4 I/O modules to meet the specifications specified in Subsection 2.1.1 and the I/O requirements of the P&IDs, instrument loop diagrams and I/O Lists.

.3 I/O

.1 120 VAC Digital Inputs: Model Number 140 DAI 540 00.

.2 24 VDC Digital Inputs: Model Number 140 DDI 353 00.

.3 Digital Outputs: Model Number 140 DRA 840 00.

.4 Analog Inputs: Model Number 140 ACI 030 00.

.5 Analog Outputs: Model Number 140 ACO 020 00.

.6 Provide at least 20% spare I/O of each type in each panel assembly.

2.2 System Integration Requirements

.1 Cooperate with other Contractors, the City and the contract administrator to facilitate installation, testing, validation, and Commissioning of the control system.

.2 Supply, install, test, and verify performance of the PLC Control Panel as specified in this Section and as shown on the Drawings.

.3 Assist the Systems Integrator to establish communication with the PLCs. Test data exchange with the PLC as specified in this Section and the process descriptions.

.4 Supply the spare PLC equipment to the systems integrator within six (6) months of award of contract.

3. EXECUTION

3.1 References – General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part 3.

END OF SECTION

OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 References – General

.1 Equipment, products, and Execution must meet all requirements detailed in Section 17010 – Instrumentation and Control General Requirements.

1.2 General Requirements

.1 For the purpose of this project, the tag name convention used on the I/O lists included with the Specifications and shown on the P&IDs will be used. Coordinate the implementation of tags for any instrumentation not listed with the Contract Administrator.

2. PRODUCTS

.1 Local Control and Operator Interfaces

.1 Provide all necessary local controls to allow local operation that compliments the operation of the WTP control system and facilitates satisfactory system control consistent with the intent of this Specification. The extent of local controls to be provided shall be fully described as part of the submittals specified in Division 11.

.2 Local operator interfaces consisting of industrial grade PC's complete with graphical interface software that has been configured for the application will be provided by others.

.2 Interface to the WTP Control System

.1 This Contractor is to support the design, installation, programming, and start-up of the WTP control system as follows:

.1 Supply all field instrumentation necessary to facilitate both local and remote monitoring and control of the system.

.2 Provide all hardware interfaces required to facilitate the interconnection of the contractor supplied PLC's to the WTP control system.

.3 Supply and install all cables, jumper wires and termination panels as shown on the Drawings and as necessary to facilitate connection of local HMIs to the WTP monitoring system and to create a complete and comprehensive WTP control and monitoring system.

.4 Update all system documentation prior to Total Performance to reflect the final installation.

3. EXECUTION

3.1 Performance – General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements, Part three.

3.2 Installation

.1 Provide hardware in accordance with the foregoing requirements in sufficient quantity to satisfy the performance requirements specified in this and other Divisions of this Specification.

.2 Provide all necessary documentation to complete the configuration of the control system including I/O lists, alarm lists, critical process variables, instrumentation lists, loop wiring requirements for I/O and local control equipment details.

.3 Assist with Performance Verification and Commissioning as specified herein.

.4 Provide all documentation and training as defined herein.

END OF SECTION

PLC I/O INDEX

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

1.2 Programmable Logic Controller Input/Output Index

.1 The following spreadsheet gives an itemized list of the I/O between the PLC and the field devices. It is intended to serve as an aid for determining the cabling requirements for the Work specified in this Division.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0001	O	LA-B010C	Level Alarm	Backwash Pump Gallery Sanitary Sump High High Level Alarm	WB-P0001							DI	
0002	O	MN-B010A	Start Command	Backwash Pump Gallery Sanitary Sump Pump Start	WB-P0001							DO	
0003	O	UF-B011A	No Fault	Backwash Pump Gallery Sanitary Sump Pump P-B011A Fault	WB-P0001							DI	
0004	O	UF-B012A	No Fault	Backwash Pump Gallery Sanitary Sump Pump P-B012A Fault	WB-P0001							DI	
0005	O	LA-B020C	Level Alarm	Fire Pump Room Sanitary Sump High High Level Alarm	WB-P0002							DI	
0006	O	MN-B020A	Start Command	Fire Pump Room Sanitary Sump Pump Start	WB-P0002							DO	
0007	O	UF-B021A	No Fault	Fire Pump Room Sanitary Sump Pump P-B021A Fault	WB-P0002							DI	
0008	O	UF-B022A	No Fault	Fire Pump Room Sanitary Sump Pump P-B022A Fault	WB-P0002							DI	
0009	O	LA-B030C	Level Alarm	Admin Area Sanitary Sump High High Level Alarm	WB-P0003							DI	
0010	O	MN-B030A	Start Command	Admin Area Sanitary Sump Pump Start	WB-P0003							DO	
0011	O	UF-B031A	No Fault	Admin Area Sanitary Sump Pump P-B031A Fault	WB-P0003							DI	
0012	O	UF-B032A	No Fault	Admin Area Sanitary Sump Pump P-B032A Fault	WB-P0003							DI	
0013	O	MN-B041A	Start Command	Elevator Pit Sanitary Pump Start	WB-P0004							DO	
0014	O	UF-B041A	No Fault	Elevator Pit Sanitary Pump Fault	WB-P0004							DI	
0015	O	MM-B051A	Running Status	Potable Water to Clearwell Area Booster Pump Running	WB-P0005							DI	
0016	O	MN-B051A	Start Command	Potable Water to Clearwell Area Booster Pump Start	WB-P0005							DO	
0017	O	PI-B051A	Pressure Indication	Potable Water to Clearwell Area Pressure	WB-P0005							AI	
0018	O	UF-B051A	No Fault	Potable Water to Clearwell Area Booster Pump Fault	WB-P0005							DI	
0019	O	YS-B051A	C/O/H Switch in Computer Position	Potable Water to Clearwell Area Booster Pump in Computer Mode	WB-P0005							DI	
0020	O	MM-B052A	Running Status	Potable Water to Water Treatment Booster Pump Running	WB-P0005							DI	
0021	O	MN-B052A	Start Command	Potable Water to Water Treatment Booster Pump Start	WB-P0005							DO	
0022	O	UF-B052A	No Fault	Potable Water to Water Treatment Booster Pump Fault	WB-P0005							DI	
0023	O	YS-B052A	C/O/H Switch in Computer Position	Potable Water to Water Treatment Booster Pump in Computer Mode	WB-P0005							DI	
0024	O	MM-B053A	Running Status	Potable Water to Water Treatment Booster Pump Running	WB-P0005							DI	
0025	O	MN-B053A	Start Command	Potable Water to Water Treatment Booster Pump Start	WB-P0005							DO	
0026	O	PI-B053A	Pressure Indication	Potable Water to Water Treatment Plant Pressure	WB-P0005							AI	
0027	O	UF-B053A	No Fault	Potable Water to Water Treatment Booster Pump Fault	WB-P0005							DI	
0028	O	YS-B053A	C/O/H Switch in Computer Position	Potable Water to Water Treatment Booster Pump in Computer Mode	WB-P0005							DI	
0029	O	FI-C001B	Flow Indication	Standby Emulsion Polymer Flow to Storage Tanks Flow Rate	WC-P0007						CP-C11	AI	
0030	O	FQ-C001B	Flow Pulse	Standby Emulsion Polymer Flow to Storage Tanks Flow Total	WC-P0007						CP-C11	DI	
0031	O	MM-C001A	Running Status	Standby Emulsion Polymer Pump Running	WC-P0007						CP-C11	DI	
0032	O	MN-C001A	Start Command	Standby Emulsion Polymer Pump Start	WC-P0007						CP-C11	DO	
0033	O	UF-C001A	No Fault	Standby Emulsion Polymer Pump Fault	WC-P0007						CP-C11	DI	
0034	O	WF-C001B	Weight Fault	Standby Emulsion Polymer Weight Fault	WC-P0007						CP-C11	DI	
0035	O	WI-C001B	Weight Indication	Standby Emulsion Polymer Weight	WC-P0007						CP-C11	AI	
0036	O	YS-C001A	C/O/H Switch in Computer Position	Standby Emulsion Polymer Pump in Computer Mode	WC-P0007						CP-C11	DI	
0037	O	LA-C005A	Level Alarm	Sludge Polymer Containment Area Level High	WC-P0007						CP-C11	DI	
0038	O	LA-C020A	Level Alarm	Filter Polymer Bulk Powder Unloading Hopper Low	WC-P0005						CP-C11	DI	
0039	O	LA-C020B	Level Alarm	Filter Polymer Bulk Powder Screw Feeder Blocked	WC-P0005						CP-C11	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0040	O	MM-C020A	Running Status	Filter Polymer Bulk Powder Unloading Blower Running	WC-P0005						CP-C11	DI	
0041	O	MN-C020A	Start Command	Filter Polymer Bulk Powder Unloading Blower Start	WC-P0005						CP-C11	DO	
0042	O	MM-C020B	Running Status	Filter Polymer Bulk Powder Unloading Screw Feeder Running	WC-P0005						CP-C11	DI	
0043	O	MN-C020B	Start Command	Filter Polymer Bulk Powder Unloading Screw Feeder Start	WC-P0005						CP-C11	DO	
0044	O	UF-C020A	No Fault	Filter Polymer Bulk Powder Unloading Blower Fault	WC-P0005						CP-C11	DI	
0045	O	UF-C020B	No Fault	Filter Polymer Bulk Powder Unloading Screw Feeder Fault	WC-P0005						CP-C11	DI	
0046	O	WF-C020A	Weight Fault	Filter Polymer Bulk Powder Weight Fault	WC-P0005						CP-C11	DI	
0047	O	WI-C020A	Weight Indication	Filter Polymer Bulk Powder Weight	WC-P0005						CP-C11	AI	
0048	O	YS-C020A	C/O/H Switch in Computer Position	Filter Polymer Bulk Powder Unloading Blower in Computer Mode	WC-P0005						CP-C11	DI	
0049	O	YS-C020B	C/O/H Switch in Computer Position	Filter Polymer Bulk Powder Unloading Screw Feeder in Computer Mode	WC-P0005						CP-C11	DI	
0050	O	LA-C021A	Level Alarm	Filter Polymer Preparation Tank High	WC-P0006						CP-C11	DI	
0051	O	LA-C021B	Level Alarm	Filter Polymer Preparation Tank Low	WC-P0006						CP-C11	DI	
0052	O	MM-C021A	Running Status	Filter Polymer Preparation Tank Mixer Running	WC-P0006						CP-C11	DI	
0053	O	MN-C021A	Start Command	Filter Polymer Preparation Tank Mixer Start	WC-P0006						CP-C11	DO	
0054	O	UF-C021A	No Fault	Filter Polymer Preparation Tank Mixer Fault	WC-P0006						CP-C11	DI	
0055	O	YB-C021A	Close Command	Filter Polymer Preparation Tank Outlet Valve Close	WC-P0006						CP-C11	DO	
0056	O	YD-C021A	Open Command	Filter Polymer Preparation Tank Outlet Valve Open	WC-P0006						CP-C11	DO	
0057	O	YS-C021A	C/O/H Switch in Computer Position	Filter Polymer Preparation Tank Mixer in Computer Mode	WC-P0006						CP-C11	DI	
0058	O	YS-C021A	C/O/H Switch in Computer Position	Filter Polymer Preparation Tank Outlet Valve in Computer Mode	WC-P0006						CP-C11	DI	
0059	O	YD-C021B	Solenoid Actuator	Filter Polymer Preparation Tank Service Water Inlet Valve Open	WC-P0006						CP-C11	DO	
0060	O	ZB-C021A	Closed Status	Filter Polymer Preparation Tank Outlet Valve Closed	WC-P0006						CP-C11	DI	
0061	O	ZD-C021A	Open Status	Filter Polymer Preparation Tank Outlet Valve Open	WC-P0006						CP-C11	DI	
0062	O	LF-C022A	Level Fault	Filter Polymer Feed Tank Level Fault	WC-P0008						CP-C11	DI	
0063	O	LI-C022A	Level Indication	Filter Polymer Feed Tank Level	WC-P0008						CP-C11	AI	
0064	O	LA-C030A	Level Alarm	Sludge Polymer Bulk Powder Unloading Hopper Low	WC-P0005						CP-C11	DI	
0065	O	LA-C030B	Level Alarm	Sludge Polymer Bulk Powder Screw Feeder Blocked	WC-P0005						CP-C11	DI	
0066	O	MM-C030A	Running Status	Sludge Polymer Bulk Powder Unloading Blower Running	WC-P0005						CP-C11	DI	
0067	O	MN-C030A	Start Command	Sludge Polymer Bulk Powder Unloading Blower Start	WC-P0005						CP-C11	DO	
0068	O	MM-C030B	Running Status	Sludge Polymer Bulk Powder Unloading Screw Feeder Running	WC-P0005						CP-C11	DI	
0069	O	MN-C030B	Start Command	Sludge Polymer Bulk Powder Unloading Screw Feeder Start	WC-P0005						CP-C11	DO	
0070	O	UF-C030A	No Fault	Sludge Polymer Bulk Powder Unloading Blower Fault	WC-P0005						CP-C11	DI	
0071	O	UF-C030B	No Fault	Sludge Polymer Bulk Powder Unloading Screw Feeder Fault	WC-P0005						CP-C11	DI	
0072	O	WF-C030A	Weight Fault	Sludge Polymer Bulk Powder Weight Fault	WC-P0005						CP-C11	DI	
0073	O	WI-C030A	Weight Indication	Sludge Polymer Bulk Powder Weight	WC-P0005						CP-C11	AI	
0074	O	YS-C030A	C/O/H Switch in Computer Position	Sludge Polymer Bulk Powder Unloading Blower in Computer Mode	WC-P0005						CP-C11	DI	
0075	O	YS-C030B	C/O/H Switch in Computer Position	Sludge Polymer Bulk Powder Unloading Screw Feeder in Computer Mode	WC-P0005						CP-C11	DI	
0076	O	LA-C031A	Level Alarm	Sludge Polymer Preparation Tank High	WC-P0007						CP-C11	DI	
0077	O	LA-C031B	Level Alarm	Sludge Polymer Preparation Tank Low	WC-P0007						CP-C11	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0078	O	MM-C031A	Running Status	Sludge Polymer Preparation Tank Mixer Running	WC-P0007						CP-C11	DI	
0079	O	MN-C031A	Start Command	Sludge Polymer Preparation Tank Mixer Start	WC-P0007						CP-C11	DO	
0080	O	UF-C031A	No Fault	Sludge Polymer Preparation Tank Mixer Fault	WC-P0007						CP-C11	DI	
0081	O	YB-C031A	Close Command	Sludge Polymer Preparation Tank Outlet Valve Close	WC-P0007						CP-C11	DO	
0082	O	YD-C031A	Open Command	Sludge Polymer Preparation Tank Outlet Valve Open	WC-P0007						CP-C11	DO	
0083	O	YS-C031A	C/O/H Switch in Computer Position	Sludge Polymer Preparation Tank Mixer in Computer Mode	WC-P0007						CP-C11	DI	
0084	O	YS-C031A	C/O/H Switch in Computer Position	Sludge Polymer Preparation Tank Outlet Valve in Computer Mode	WC-P0007						CP-C11	DI	
0085	O	YD-C031B	Solenoid Actuator	Sludge Polymer Preparation Tank Service Water Inlet Valve Open	WC-P0007						CP-C11	DO	
0086	O	ZB-C031A	Closed Status	Sludge Polymer Preparation Tank Outlet Valve Closed	WC-P0007						CP-C11	DI	
0087	O	ZD-C031A	Open Status	Sludge Polymer Preparation Tank Outlet Valve Open	WC-P0007						CP-C11	DI	
0088	O	LF-C032A	Level Fault	Sludge Polymer Feed Tank Level Fault	WC-P0009						CP-C11	DI	
0089	O	LI-C032A	Level Indication	Sludge Polymer Feed Tank Level	WC-P0009						CP-C11	AI	
0090	O	FA-C061A	Flow Alarm	Service Water to P-C061A Low Flow	WC-P0014						CP-C11	DI	
0091	O	FI-C061A	Flow Indication	Filter Polymer Feed Pump P-C061A Discharge Flow Rate	WC-P0014						CP-C11	AI	
0092	O	FQ-C061A	Flow Pulse	Filter Polymer Feed Pump P-C061A Discharge Flow Total	WC-P0014						CP-C11	DI	
0093	O	MM-C061A	Running Status	Filter Polymer Feed Pump P-C061A Running	WC-P0014						CP-C11	DI	
0094	O	MN-C061A	Start Command	Filter Polymer Feed Pump P-C061A Start	WC-P0014						CP-C11	DO	
0095	O	SC-C061A	Speed Control Output	Filter Polymer Feed Pump P-C061A Required Speed	WC-P0014						CP-C11	AO	
0096	O	SI-C061A	Speed Indication	Filter Polymer Feed Pump P-C061A Speed	WC-P0014						CP-C11	AI	
0097	O	UF-C061A	No Fault	Filter Polymer Feed Pump P-C061A Fault	WC-P0014						CP-C11	DI	
0098	O	YD-C061A	Open Command	Service Water to P-C061A Discharge Flow Control Valve Open	WC-P0014						CP-C11	DO	
0099	O	YS-C061A	C/O/H Switch in Computer Position	Filter Polymer Feed Pump P-C061A in Computer Mode	WC-P0014						CP-C11	DI	
0100	O	FA-C062A	Flow Alarm	Service Water to P-C062A Low Flow	WC-P0014						CP-C11	DI	
0101	O	FI-C062A	Flow Indication	Filter Polymer Feed Pump P-C062A Discharge Flow Rate	WC-P0014						CP-C11	AI	
0102	O	FQ-C062A	Flow Pulse	Filter Polymer Feed Pump P-C062A Discharge Flow Total	WC-P0014						CP-C11	DI	
0103	O	MM-C062A	Running Status	Filter Polymer Feed Pump P-C062A Running	WC-P0014						CP-C11	DI	
0104	O	MN-C062A	Start Command	Filter Polymer Feed Pump P-C062A Start	WC-P0014						CP-C11	DO	
0105	O	SC-C062A	Speed Control Output	Filter Polymer Feed Pump P-C062A Required Speed	WC-P0014						CP-C11	AO	
0106	O	SI-C062A	Speed Indication	Filter Polymer Feed Pump P-C062A Speed	WC-P0014						CP-C11	AI	
0107	O	UF-C062A	No Fault	Filter Polymer Feed Pump P-C062A Fault	WC-P0014						CP-C11	DI	
0108	O	YD-C062A	Open Command	Service Water to P-C062A Discharge Flow Control Valve Open	WC-P0014						CP-C11	DO	
0109	O	YS-C062A	C/O/H Switch in Computer Position	Filter Polymer Feed Pump P-C062A in Computer Mode	WC-P0014						CP-C11	DI	
0110	O	FA-C063A	Flow Alarm	Service Water to P-C063A Low Flow	WC-P0014						CP-C11	DI	
0111	O	FI-C063A	Flow Indication	Filter Polymer Feed Pump P-C063A Discharge Flow Rate	WC-P0014						CP-C11	AI	
0112	O	FQ-C063A	Flow Pulse	Filter Polymer Feed Pump P-C063A Discharge Flow Total	WC-P0014						CP-C11	DI	
0113	O	MM-C063A	Running Status	Filter Polymer Common Standby Feed Pump Running	WC-P0014						CP-C11	DI	
0114	O	MN-C063A	Start Command	Filter Polymer Common Standby Feed Pump Start	WC-P0014						CP-C11	DO	
0115	O	SC-C063A	Speed Control Output	Filter Polymer Common Standby Feed Pump Required Speed	WC-P0014						CP-C11	AO	
0116	O	SI-C063A	Speed Indication	Filter Polymer Common Standby Feed Pump Speed	WC-P0014						CP-C11	AI	
0117	O	UF-C063A	No Fault	Filter Polymer Common Standby Feed Pump Fault	WC-P0014						CP-C11	DI	
0118	O	YD-C063A	Open Command	Service Water to P-C063A Discharge Flow Control Valve Open	WC-P0014						CP-C11	DO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0119	O	YS-C063A	C/O/H Switch in Computer Position	Filter Polymer Common Standby Feed Pump in Computer Mode	WC-P0014						CP-C11	DI	
0120	O	YB-C064B	Close Command	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Close	WC-P0014						CP-C11	DO	
0121	O	YD-C064B	Open Command	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Open	WC-P0014						CP-C11	DO	
0122	O	YS-C064B	C/O/H Switch in Computer Position	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve in Computer Mode	WC-P0014						CP-C11	DI	
0123	O	ZB-C064B	Closed Status	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Closed	WC-P0014						CP-C11	DI	
0124	O	ZD-C064B	Open Status	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Open	WC-P0014						CP-C11	DI	
0125	O	YB-C065B	Close Command	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Close	WC-P0014						CP-C11	DO	
0126	O	YD-C065B	Open Command	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Open	WC-P0014						CP-C11	DO	
0127	O	YS-C065B	C/O/H Switch in Computer Position	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve in Computer Mode	WC-P0014						CP-C11	DI	
0128	O	ZB-C065B	Closed Status	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Closed	WC-P0014						CP-C11	DI	
0129	O	ZD-C065B	Open Status	Common Standby Pump P-C063A to Filter Aid Mixing Chamber Control Valve Open	WC-P0014						CP-C11	DI	
0130	O	FA-C071A	Flow Alarm	Service Water to P-C071A Low Flow	WC-P0015						CP-C11	DI	
0131	O	FI-C071A	Flow Indication	Sludge Polymer Feed Pump P-C071A Discharge Flow Rate	WC-P0015						CP-C11	AI	
0132	O	FQ-C071A	Flow Pulse	Sludge Polymer Feed Pump P-C071A Discharge Flow Total	WC-P0015						CP-C11	DI	
0133	O	MM-C071A	Running Status	Sludge Polymer Feed Pump P-C071A Running	WC-P0015						CP-C11	DI	
0134	O	MN-C071A	Start Command	Sludge Polymer Feed Pump P-C071A Start	WC-P0015						CP-C11	DO	
0135	O	SC-C071A	Speed Control Output	Sludge Polymer Feed Pump P-C071A Speed Indication	WC-P0015						CP-C11	AO	
0136	O	SI-C071A	Speed Indication	Sludge Polymer Feed Pump P-C071A Speed	WC-P0015						CP-C11	AI	
0137	O	UF-C071A	No Fault	Sludge Polymer Feed Pump P-C071A Fault	WC-P0015						CP-C11	DI	
0138	O	YD-C071A	Open Command	Service Water to P-C071 Discharge Flow Control Valve Open	WC-P0015						CP-C11	DO	
0139	O	YS-C071A	C/O/H Switch in Computer Position	Sludge Polymer Feed Pump P-C071A in Computer Mode	WC-P0015						CP-C11	DI	
0140	O	YB-C071A	Close Command	Sludge Polymer Feed Pump P-C071A Discharge Flow Control Valve Closed	WC-P0015						CP-C11	DO	
0141	O	YD-C071B	Open Command	Sludge Polymer Feed Pump P-C071A Discharge Flow Control Valve Open	WC-P0015						CP-C11	DO	
0142	O	YS-C071A	C/O/H Switch in Computer Position	Sludge Polymer Feed Pump P-C071A Discharge Flow Control Valve in Computer Mode	WC-P0015						CP-C11	DI	
0143	O	ZB-C071A	Closed Status	Sludge Polymer Feed Pump P-C071A Discharge Flow Control Valve Closed	WC-P0015						CP-C11	DI	
0144	O	ZD-C071A	Open Status	Sludge Polymer Feed Pump P-C071A Discharge Flow Control Valve Open	WC-P0015						CP-C11	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0145	O	FA-C072A	Flow Alarm	Service Water to P-C072A Low Flow	WC-P0015						CP-C11	DI	
0146	O	FI-C072A	Flow Indication	Sludge Polymer Feed Pump P-C072A Discharge Flow Rate	WC-P0015						CP-C11	AI	
0147	O	FT-C072A	Flow Pulse	Sludge Polymer Feed Pump P-C072A Discharge Flow Total	WC-P0015						CP-C11	DI	
0148	O	MM-C072A	Running Status	Sludge Polymer Feed Pump P-C072A Running	WC-P0015						CP-C11	DI	
0149	O	MN-C072A	Start Command	Sludge Polymer Feed Pump P-C072A Start	WC-P0015						CP-C11	DO	
0150	O	SC-C072A	Speed Control Output	Sludge Polymer Feed Pump P-C072A Speed Indication	WC-P0015						CP-C11	AO	
0151	O	SI-C072A	Speed Indication	Sludge Polymer Feed Pump P-C072A Speed	WC-P0015						CP-C11	AI	
0152	O	UF-C072A	No Fault	Sludge Polymer Feed Pump P-C072A Fault	WC-P0015						CP-C11	DI	
0153	O	YD-C072A	Open Command	Service Water to P-C072A Discharge Flow Control Valve Open	WC-P0015						CP-C11	DO	
0154	O	YS-C072A	C/O/H Switch in Computer Position	Sludge Polymer Feed Pump P-C072A in Computer Mode	WC-P0015						CP-C11	DI	
0155	O	LF-C701A	Level Fault	Filter Inlet Chamber (TK-C701A) Level Fault	WO-P0010							DI	
0156	O	LI-C701A	Level Indication	Filter Inlet Chamber (TK-C701A) Level	WO-P0010							AI	
0157	O	MM-C701A	Running Status	Filter Inlet Chamber (TK-C701A) Mixer Running	WO-P0010							DI	
0158	O	MN-C701A	Start Command	Filter Inlet Chamber (TK-C701A) Mixer Start	WO-P0010							DO	
0159	O	UF-C701A	No Fault	Filter Inlet Chamber (TK-C701A) Mixer Fault	WO-P0010							DI	
0160	O	YS-C701A	C/O/H Switch in Computer Position	Filter Inlet Chamber (TK-C701A) Mixer in Computer Mode	WO-P0010							DI	
0161	O	LF-C702A	Level Fault	Filter Inlet Chamber (TK-C702A) Level	WO-P0011							DI	
0162	O	LI-C702A	Level Indication	Filter Inlet Chamber (TK-C702A) Level	WO-P0011							AI	
0163	O	MM-C702A	Running Status	Filter Inlet Chamber (TK-C702A) Mixer Running	WO-P0011							DI	
0164	O	MN-C702A	Start Command	Filter Inlet Chamber (TK-C702A) Mixer Start	WO-P0011							DO	
0165	O	UF-C702A	No Fault	Filter Inlet Chamber (TK-C702A) Mixer Fault	WO-P0011							DI	
0166	O	YS-C702A	C/O/H Switch in Computer Position	Filter Inlet Chamber (TK-C702A) Mixer in Computer Mode	WO-P0011							DI	
0167	O	LS-C800A	Level Alarm	Hydrogen Peroxide Spill Containment High Level	WC-P0001						CP-H30	DO	
0168	O	LF-C810A	Level Fault	Hydrogen Peroxide Feed Tank TKC810A Level Fault	WC-P0001						CP-H30	DI	
0169	O	LI-C810A	Level Indication	Hydrogen Peroxide Feed Tank TKC810A Level	WC-P0001						CP-H30	AI	
0170	O	YB-C810B	Close Command	Hydrogen Peroxide Feed Tank TKC810A Inlet Control Valve Close	WC-P0001						CP-H30	DO	
0171	O	YD-C810B	Open Command	Hydrogen Peroxide Feed Tank TKC810A Inlet Control Valve Open	WC-P0001						CP-H30	DO	
0172	O	YS-C810B	C/O/H Switch in Computer Position	Hydrogen Peroxide Feed Tank TKC810A Inlet Control Valve in Computer Mode	WC-P0001						CP-H30	DI	
0173	O	ZB-C810B	Closed Status	Hydrogen Peroxide Feed Tank TKC810A Inlet Control Valve Closed	WC-P0001						CP-H30	DI	
0174	O	ZD-C810B	Open Status	Hydrogen Peroxide Feed Tank TKC810A Inlet Control Valve Open	WC-P0001						CP-H30	DI	
0175	O	LF-C820A	Level Indicator Transmitter	Hydrogen Peroxide Feed Tank TKC820A Level Fault	WC-P0001						CP-H30	DI	
0176	O	LI-C820A	Level Indication	Hydrogen Peroxide Feed Tank TKC820A Level	WC-P0001						CP-H30	AI	
0177	O	YB-C820B	Close Command	Hydrogen Peroxide Feed Tank TKC820A Inlet Control Valve Close	WC-P0001						CP-H30	DO	
0178	O	YD-C820B	Open Command	Hydrogen Peroxide Feed Tank TKC820A Inlet Control Valve Open	WC-P0001						CP-H30	DO	
0179	O	YS-C820B	C/O/H Switch in Computer Position	Hydrogen Peroxide Feed Tank TKC820A Inlet Control Valve in Computer Mode	WC-P0001						CP-H30	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0180	O	ZB-C820B	Closed Status	Hydrogen Peroxide Feed Tank TKC820A Inlet Control Valve Closed	WC-P0001						CP-H30	DI	
0181	O	ZD-C820B	Open Status	Hydrogen Peroxide Feed Tank TKC820A Inlet Control Valve Open	WC-P0001						CP-H30	DI	
0182	O	FA-C840A	Flow Alarm	Service Water to P-C840A Low Flow	WC-P0002						CP-H30	DI	
0183	O	MM-C840A	Running Status	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump Running	WC-P0002						CP-H30	DI	
0184	O	MN-C840A	Start Command	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump Start	WC-P0002						CP-H30	DO	
0185	O	SC-C840A	Speed Control Output	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump Required Speed	WC-P0002						CP-H30	AO	
0186	O	SI-C840A	Speed Indication	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump Speed	WC-P0002						CP-H30	AI	
0187	O	UF-C840A	No Fault	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump Fault	WC-P0002						CP-H30	DI	
0188	O	YD-C840A	Open Command	Service Water to P-C840A Discharge Flow Control Valve Open	WC-P0002						CP-H30	DO	
0189	O	YS-C840A	C/O/H Switch in Computer Position	Hydrogen Peroxide Dosing to Ozone Contactor #1 Pump in Computer Mode	WC-P0002						CP-H30	DI	
0190	O	FA-C850A	Flow Alarm	Service Water to P-C850A Low Flow	WC-P0002						CP-H30	DI	
0191	O	MM-C850A	Running Status	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump Running	WC-P0002						CP-H30	DI	
0192	O	MN-C850A	Start Command	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump Start	WC-P0002						CP-H30	DO	
0193	O	SC-C850A	Speed Control Output	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump Required Speed	WC-P0002						CP-H30	AO	
0194	O	SI-C850A	Speed Indication	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump Speed	WC-P0002						CP-H30	AI	
0195	O	UF-C850A	No Fault	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump Fault	WC-P0002						CP-H30	DI	
0196	O	YS-C850A	C/O/H Switch in Computer Position	Hydrogen Peroxide Dosing to Ozone Contactor #2 Pump in Computer Mode	WC-P0002						CP-H30	DI	
0197	O	YD-C850A	Open Command	Service Water to P-C850A Discharge Flow Control Valve Open	WC-P0002						CP-H30	DO	
0198	O	FA-C860A	Flow Alarm	Service Water to P-C860A Low Flow	WC-P0002						CP-H30	DO	
0199	O	MM-C860A	Running Status	Common Standby Hydrogen Peroxide Dosing Pump Running	WC-P0002						CP-H30	DI	
0200	O	MN-C860A	Start Command	Common Standby Hydrogen Peroxide Dosing Pump Start	WC-P0002						CP-H30	DO	
0201	O	SC-C860A	Speed Control Output	Common Standby Hydrogen Peroxide Dosing Pump Required Speed	WC-P0002						CP-H30	AO	
0202	O	SI-C860A	Speed Indication	Common Standby Hydrogen Peroxide Dosing Pump Speed	WC-P0002						CP-H30	AI	
0203	O	UF-C860A	No Fault	Common Standby Hydrogen Peroxide Dosing Pump Fault	WC-P0002						CP-H30	DI	
0204	O	YS-C860A	C/O/H Switch in Computer Position	Common Standby Hydrogen Peroxide Dosing Pump in Computer Mode	WC-P0002						CP-H30	DI	
0205	O	YD-C860A	Open Command	Service Water to P-C860A Discharge Flow Control Valve Open	WC-P0002						CP-H30	DI	
0206	O	YB-C860C	Close Command	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #1 Valve Close	WC-P0002						CP-H30	DO	
0207	O	YD-C860C	Open Command	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #1 Valve Open	WC-P0002						CP-H30	DO	
0208	O	YS-C860C	C/O/H Switch in Computer Position	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #1 Valve in Computer Mode	WC-P0002						CP-H30	DI	
0209	O	YB-C860D	Close Command	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #2 Valve Close	WC-P0002						CP-H30	DO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0210	O	YD-C860D	Open Command	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #2 Valve Open	WC-P0002						CP-H30	DO	
0211	O	YS-C860D	C/O/H Switch in Computer Position	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #2 Valve in Computer Mode	WC-P0002						CP-H30	DI	
0212	O	ZB-C860C	Closed Status	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #1 Valve Closed	WC-P0002						CP-H30	DI	
0213	O	ZD-C860C	Open Status	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #1 Valve Open	WC-P0002						CP-H30	DI	
0214	O	ZB-C860D	Closed Status	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #2 Valve Closed	WC-P0002						CP-H30	DI	
0215	O	ZD-C860D	Open Status	Hydrogen Peroxide Dosing Pump P-C860A to Ozone Contactor #2 Valve Open	WC-P0002						CP-H30	DI	
0216	O	LF-C940B	Level Fault	Sodium Bisulphite Feed Tank Level Fault	WC-P0003						CP-H30	DI	
0217	O	LI-C940B	Level Indication	Sodium Bisulphite Feed Tank Level	WC-P0003						CP-H30	AI	
0218	O	MM-C950A	Running Status	Sodium Bisulphite Pump to Ozone Contactor #1 Running	WC-P0004						CP-H30	DI	
0219	O	MN-C950A	Start Command	Sodium Bisulphite Pump to Ozone Contactor #1 Start	WC-P0004						CP-H30	DO	
0220	O	SC-C950A	Speed Control Output	Sodium Bisulphite Pump to Ozone Contactor #1 Required Speed	WC-P0004						CP-H30	AO	
0221	O	SI-C950A	Speed Indication	Sodium Bisulphite Pump to Ozone Contactor #1 Speed	WC-P0004						CP-H30	AI	
0222	O	UF-C950A	No Fault	Sodium Bisulphite Pump to Ozone Contactor #1 Fault	WC-P0004						CP-H30	DI	
0223	O	YS-C950A	C/O/H Switch in Computer Position	Sodium Bisulphite Pump to Ozone Contactor #1 in Computer Mode	WC-P0004						CP-H30	DI	
0224	O	MM-C960A	Running Status	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 Running	WC-P0004						CP-H30	DI	
0225	O	MN-C960A	Start Command	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 Start	WC-P0004						CP-H30	DO	
0226	O	SC-C960A	Speed Control Output	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 Required Speed	WC-P0004						CP-H30	AO	
0227	O	SI-C960A	Speed Indication	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 Speed	WC-P0004						CP-H30	AI	
0228	O	UF-C960A	No Fault	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 Fault	WC-P0004						CP-H30	DI	
0229	O	YS-C960A	C/O/H Switch in Computer Position	Sodium Bisulphite Pump P-C960A to Ozone Contactor #2 in Computer Mode	WC-P0004						CP-H30	DI	
0230	O	MM-C970A	Running Status	Common Standby Sodium Bisulphite Pump Running	WC-P0004						CP-H30	DI	
0231	O	MN-C970A	Start Command	Common Standby Sodium Bisulphite Pump Start	WC-P0004						CP-H30	DO	
0232	O	SC-C970A	Speed Control Output	Common Standby Sodium Bisulphite Pump Required Speed	WC-P0004						CP-H30	AO	
0233	O	SI-C970A	Speed Indication	Common Standby Sodium Bisulphite Pump Speed	WC-P0004						CP-H30	AI	
0234	O	UF-C970A	No Fault	Common Standby Sodium Bisulphite Pump Fault	WC-P0004						CP-H30	DI	
0235	O	YS-C970A	C/O/H Switch in Computer Position	Common Standby Sodium Bisulphite Pump in Computer Mode	WC-P0004						CP-H30	DI	
0236	O	YB-C970C	Close Command	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Close	WC-P0004						CP-H30	DO	
0237	O	YD-C970C	Open Command	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Open	WC-P0004						CP-H30	DO	
0238	O	YS-C970C	C/O/H Switch in Computer Position	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve in Computer Mode	WC-P0004						CP-H30	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0239	O	YB-C970D	Close Command	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Close	WC-P0004						CP-H30	DO	
0240	O	YD-C970D	Open Command	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Open	WC-P0004						CP-H30	DO	
0241	O	YS-C970D	C/O/H Switch in Computer Position	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve in Computer Mode	WC-P0004						CP-H30	DI	
0242	O	ZB-C970C	Closed Status	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Closed	WC-P0004						CP-H30	DI	
0243	O	ZD-C970C	Open Status	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Open	WC-P0004						CP-H30	DI	
0244	O	ZB-C970D	Closed Status	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Closed	WC-P0004						CP-H30	DI	
0245	O	ZD-C970D	Open Status	Sodium Bisulphite Dosing Pump P-C970A to Ozone Contactor #2 Valve Open	WC-P0004						CP-H30	DI	
0246	O	LA-C980A	Level Alarm	Sodium Bisulphite Spill Containment High Level	WC-P0003						CP-H30	DI	
0247	O	LF-F001A	Level Fault	Filter Influent Channel Level Fault	WO-P0010							DI	
0248	O	LI-F001A	Level Indication	Filter Influent Channel Level	WO-P0010							AI	
0249	O	LF-F002A	Level Fault	Filter Influent Channel Level Fault	WO-P0011							DI	
0250	O	LI-F002A	Level Indication	Filter Influent Channel Level	WO-P0011							AI	
0251	O	MM-F010A	Running Status	Filter Air Scour Blower BLW-F010A Running	WF-P0010						CP-H30	DI	
0252	O	MN-F010A	Start Command	Filter Air Scour Blower BLW-F010A Start	WF-P0010						CP-H30	DO	
0253	O	PI-F010A	Pressure Indication	Filter Air Scour Blower BLW-F010A Inlet Air Filter Differential Pressure	WF-P0010						CP-H30	AI	
0254	O	PI-F010B	Pressure Indication	Filter Air Scour Blower BLW-F010A Outlet Air Pressure	WF-P0010						CP-H30	AI	
0255	O	TI-F010A	Temperature Indication	Filter Air Scour Blower BLW-F010A Winding Temperature	WF-P0010						CP-H30	AI TCP	
0256	O	TI-F010B	Temperature Indication	Filter Air Scour Blower BLW-F010A Front Bearing Temperature	WF-P0010						CP-H30	AI TCP	
0257	O	TI-F010C	Temperature Indication	Filter Air Scour Blower BLW-F010A Back Bearing Temperature	WF-P0010						CP-H30	AI TCP	
0258	O	UF-F010A	No Fault	Filter Air Scour Blower BLW-F010A Fault	WF-P0010						CP-H30	DI	
0259	O	VT-F010A	Vibration Indication	Filter Air Scour Blower BLW-F010A Vibration	WF-P0010						CP-H30	AI	
0260	O	YB-F010A	Close Command	Filter Air Scour Blower BLW-F010A Outlet Control Valve Close	WF-P0010						CP-H30	DO	
0261	O	YD-F010A	Open Command	Filter Air Scour Blower BLW-F010A Outlet Control Valve Open	WF-P0010						CP-H30	DO	
0262	O	YS-F010A	C/O/H Switch in Computer Position	Filter Air Scour Blower BLW-F010A in Computer Mode	WF-P0010						CP-H30	DI	
0263	O	YS-F010A	C/O/H Switch in Computer Position	Filter Air Scour Blower BLW-F010A Outlet Control Valve in Computer Mode	WF-P0010						CP-H30	DI	
0264	O	ZB-F010A	Closed Status	Filter Air Scour Blower BLW-F010A Outlet Control Valve Closed	WF-P0010						CP-H30	DI	
0265	O	ZD-F010A	Open Status	Filter Air Scour Blower BLW-F010A Outlet Control Valve Open	WF-P0010						CP-H30	DI	
0266	O	MM-F020A	Running Status	Filter Air Scour Blower BLW-F020A Running	WF-P0010						CP-H30	DI	
0267	O	MN-F020A	Start Command	Filter Air Scour Blower BLW-F020A Start	WF-P0010						CP-H30	DO	
0268	O	PI-F020A	Pressure Indication	Filter Air Scour Blower BLW-F020A Inlet Air Filter Differential Pressure	WF-P0010						CP-H30	AI	
0269	O	PT-F020B	Pressure Indication	Filter Air Scour Blower BLW-F020A Outlet Air Pressure	WF-P0010						CP-H30	AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0270	O	TI-F020A	Temperature Indication	Filter Air Scour Blower BLW-F020A Winding Temperature	WF-P0010						CP-H30	AI TCP	
0271	O	TI-F020B	Temperature Indication	Filter Air Scour Blower BLW-F020A Front Bearing Temperature	WF-P0010						CP-H30	AI TCP	
0272	O	TI-F020C	Temperature Indication	Filter Air Scour Blower BLW-F020A Back Bearing Temperature	WF-P0010						CP-H30	AI TCP	
0273	O	UF-F020A	No Fault	Filter Air Scour Blower BLW-F020A Fault	WF-P0010						CP-H30	DI	
0274	O	VI-F020A	Vibration Indication	Filter Air Scour Blower BLW-F020A High Vibration	WF-P0010						CP-H30	AI	
0275	O	YB-F020A	Close Command	Filter Air Scour Blower BLW-F020A Outlet Control Valve Close	WF-P0010						CP-H30	DO	
0276	O	YD-F020A	Open Command	Filter Air Scour Blower BLW-F020A Outlet Control Valve Open	WF-P0010						CP-H30	DO	
0277	O	YS-F020A	C/O/H Switch in Computer Position	Filter Air Scour Blower BLW-F020A in Computer Mode	WF-P0010						CP-H30	DI	
0278	O	YS-F020A	C/O/H Switch in Computer Position	Filter Air Scour Blower BLW-F020A Outlet Control Valve in Computer Mode	WF-P0010						CP-H30	DI	
0279	O	ZB-F020A	Closed Status	Filter Air Scour Blower BLW-F020A Outlet Control Valve Closed	WF-P0010						CP-H30	DI	
0280	O	ZD-F020A	Open Status	Filter Air Scour Blower BLW-F020A Outlet Control Valve Open	WF-P0010						CP-H30	DI	
0281	O	FI-F030A	Flow Indication	Filter Air Scour Blower Outlet Flow Rate	WF-P0010						CP-H30	AI	
0282	O	TI-F030A	Temperature Indication	Filter Air Scour Blower Outlet Temperature	WF-P0010						CP-H30	AI	
0283	O	LF-F050A	Level Fault	Filtered Water Chamber Level Fault	WF-P0011						LCP-R21	DI	
0284	O	LI-F050A	Level Indication	Filtered Water Chamber Level	WF-P0011						LCP-R21	AI	
0285	O	YB-F051A	Close Command	Filter No. 1-4 Outlet to Filtered Water Chamber Valve Close	WF-P0011						LCP-F01	DO	
0286	O	YD-F051A	Open Command	Filter No. 1-4 Outlet to Filtered Water Chamber Valve Open	WF-P0011						LCP-F01	DO	
0287	O	YS-F051A	C/O/H Switch in Computer Position	Filter No. 1-4 Outlet to Filtered Water Chamber Valve in Computer Mode	WF-P0011						LCP-F01	DI	
0288	O	ZB-F051A	Closed Status	Filter No. 1-4 Outlet to Filtered Water Chamber Valve Closed	WF-P0011						LCP-F01	DI	
0289	O	ZD-F051A	Open Status	Filter No. 1-4 Outlet to Filtered Water Chamber Valve Open	WF-P0011						LCP-F01	DI	
0290	O	YB-F052A	Close Command	Filter No. 5-8 Outlet to Filtered Water Chamber Valve Close	WF-P0011						LCP-F02	DO	
0291	O	YD-F052A	Open Command	Filter No. 5-8 Outlet to Filtered Water Chamber Valve Open	WF-P0011						LCP-F02	DO	
0292	O	YS-F052A	C/O/H Switch in Computer Position	Filter No. 5-8 Outlet to Filtered Water Chamber Valve in Computer Mode	WF-P0011						LCP-F02	DI	
0293	O	ZB-F052A	Closed Status	Filter No. 5-8 Outlet to Filtered Water Chamber Valve Closed	WF-P0011						LCP-F02	DI	
0294	O	ZD-F052A	Open Status	Filter No. 5-8 Outlet to Filtered Water Chamber Valve Open	WF-P0011						LCP-F02	DI	
0295	O	ZB-F053A	Closed Status	Filtered Water Chamber to Chlorine Contact Tank Sluice Gate Closed	WF-P0011						LCP-R21	DI	
0296	O	ZD-F053A	Open Status	Filtered Water Chamber to Chlorine Contact Tank Sluice Gate Open	WF-P0011						LCP-R21	DI	
0297	O	ZB-F054A	Closed Status	Filtered Water Chamber Chlorine Contact Tank Bypass Sluice Gate Closed	WF-P0011						LCP-R21	DI	
0298	O	ZD-F054A	Open Status	Filtered Water Chamber Chlorine Contact Tank Bypass Sluice Gate Open	WF-P0011						LCP-R21	DI	
0299	O	FA-F055A	Flow Switch	Chlorine Contact Tank to Supernatent Pump Station Drain Pump Outlet Flow	WF-P0012						LCP-F01	DI	
0300	O	MM-F055A	Running Status	Chlorine Contact Tank to Supernatent Pump Station Drain Pump P-F055A Running	WF-P0012						LCP-F01	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0301	O	MN-F055A	Start Command	Chlorine Contact Tank to Supernatent Pump Station Drain Pump P-F055A Start	WF-P0012						LCP-F01	DO	
0302	O	UF-F055A	No Fault	Chlorine Contact Tank to Supernatent Pump Station Drain Pump P-F055A Fault	WF-P0012						LCP-F01	DI	
0303	O	YS-F055A	C/O/H Switch in Computer Position	Chlorine Contact Tank to Supernatent Pump Station Drain Pump P-F055A in Computer Mode	WF-P0012						LCP-F01	DI	
0304	O	ZB-F055A	Closed Status	Chlorine Contact Tank Outlet Sluice Gate Closed	WF-P0011						LCP-R21	DI	
0305	O	ZD-F055A	Open Status	Chlorine Contact Tank Outlet Sluice Gate Open	WF-P0011						LCP-R21	DI	
0306	O	AI-F056A	Free Chlorine Indication	Chlorine Contact Tank Outlet Free Chlorine Measurement	WF-P0011						LCP-F01	AI	
0307	O	FA-F056A	Flow Alarm	Chlorine Contact Tank Outlet Free Chlorine Sample Low Flow	WF-P0011						LCP-F01	DI	
0308	O	LF-F100A	Level Fault	Filter No. 1 Level Fault	WF-P0001						CP-H30	DI	
0309	O	LI-F100A	Level Indication	Filter No. 1 Level	WF-P0001						CP-H30	AI	
0310	O	PI-F100A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0001						LCP-F01	AI	
0311	O	YB-F101A	Close Command	Filter TKF100A Inlet Valve Close	WF-P0001						CP-H30	DO	
0312	O	YD-F101A	Open Command	Filter TKF100A Inlet Valve Open	WF-P0001						CP-H30	DO	
0313	O	YS-F101A	C/O/H Switch in Computer Position	Filter TKF100A Inlet Valve in Computer Mode	WF-P0001						CP-H30	DI	
0314	O	ZB-F101A	Closed Status	Filter TKF100A Inlet Valve Closed	WF-P0001						CP-H30	DI	
0315	O	ZD-F101A	Open Status	Filter TKF100A Inlet Valve Open	WF-P0001						CP-H30	DI	
0316	O	YB-F102A	Close Command	Filter TKF100A Backwash Water Outlet Valve Close	WF-P0001						CP-H30	DO	
0317	O	YD-F102A	Open Command	Filter TKF100A Backwash Water Outlet Valve Open	WF-P0001						CP-H30	DO	
0318	O	YS-F102A	C/O/H Switch in Computer Position	Filter TKF100A Backwash Water Outlet Valve in Computer Mode	WF-P0001						CP-H30	DI	
0319	O	ZB-F102A	Closed Status	Filter TKF100A Backwash Water Outlet Valve Closed	WF-P0001						CP-H30	DI	
0320	O	ZD-F102A	Open Status	Filter TKF100A Backwash Water Outlet Valve Open	WF-P0001						CP-H30	DI	
0321	O	FI-F103A	Flow Indication	Filter TKF100A Outlet Flow Rate	WF-P0001						LCP-F01	AI	
0322	O	FQ-F103A	Flow Pulse	Filter TKF100A Outlet Flow Total	WF-P0001						LCP-F01	DI	
0323	O	YS-F103A	C/O/H Switch in Computer Position	Filter TKF100A Outlet Flow Control Valve in Computer Mode	WF-P0001						LCP-F01	DI	
0324	O	ZB-F103A	Closed Status	Filter TKF100A Outlet Flow Control Valve Closed	WF-P0001						LCP-F01	DI	
0325	O	ZC-F103A	Position Control Output	Filter TKF100A Outlet Flow Control Valve Required Position	WF-P0001						LCP-F01	AO	
0326	O	ZD-F103A	Open Status	Filter TKF100A Outlet Flow Control Valve Open	WF-P0001						LCP-F01	DI	
0327	O	ZT-F103A	Position Feedback	Filter TKF100A Outlet Flow Control Valve Position	WF-P0001						LCP-F01	AI	
0328	O	YB-F104A	Close Command	Filter TKF100A Outlet Flow Valve Closed	WF-P0001						LCP-F01	DO	
0329	O	YD-F104A	Open Command	Filter TKF100A Outlet Flow Valve Open	WF-P0001						LCP-F01	DO	
0330	O	YS-F104A	C/O/H Switch in Computer Position	Filter TKF100A Outlet Flow Valve in Computer Mode	WF-P0001						LCP-F01	DI	
0331	O	ZB-F104A	Closed Status	Filter TKF100A Outlet Flow Valve Closed	WF-P0001						LCP-F01	DI	
0332	O	ZD-F104A	Open Status	Filter TKF100A Outlet Flow Valve Open	WF-P0001						LCP-F01	DI	
0333	O	YB-F105A	Close Command	Filter TKF100A Outlet Flow to Backwash Tank Valve Close	WF-P0001						LCP-F01	DO	
0334	O	YD-F105A	Open Command	Filter TKF100A Outlet Flow to Backwash Tank Valve Open	WF-P0001						LCP-F01	DO	
0335	O	YS-F105A	C/O/H Switch in Computer Position	Filter TKF100A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0001						LCP-F01	DI	
0336	O	ZB-F105A	Closed Status	Filter TKF100A Outlet Flow to Backwash Tank Valve Closed	WF-P0001						LCP-F01	DI	
0337	O	ZD-F105A	Open Status	Filter TKF100A Outlet Flow to Backwash Tank Valve Open	WF-P0001						LCP-F01	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0338	O	YB-F106A	Close Command	Filter TKF100A Backwash Water Inlet Valve Closed	WF-P0001						LCP-F01	DO	
0339	O	YD-F106A	Open Command	Filter TKF100A Backwash Water Inlet Valve Open	WF-P0001						LCP-F01	DO	
0340	O	YS-F106A	C/O/H Switch in Computer Position	Filter TKF100A Backwash Water Inlet Valve in Computer Mode	WF-P0001						LCP-F01	DI	
0341	O	ZB-F106A	Closed Status	Filter TKF100A Backwash Water Inlet Valve Closed	WF-P0001						LCP-F01	DI	
0342	O	ZD-F106A	Open Status	Filter TKF100A Backwash Water Inlet Valve Open	WF-P0001						LCP-F01	DI	
0343	O	YB-F107A	Close Command	Filter TKF100A Air Scour Valve Closed	WF-P0001						LCP-F01	DO	
0344	O	YD-F107A	Open Command	Filter TKF100A Air Scour Valve Open	WF-P0001						LCP-F01	DO	
0345	O	YS-F107A	C/O/H Switch in Computer Position	Filter TKF100A Air Scour Valve in Computer Mode	WF-P0001						LCP-F01	DI	
0346	O	ZB-F107A	Closed Status	Filter TKF100A Air Scour Valve Closed	WF-P0001						LCP-F01	DI	
0347	O	ZD-F107A	Open Status	Filter TKF100A Air Scour Valve Open	WF-P0001						LCP-F01	DI	
0348	O	AF-F110A	Turbidity Fault	Filter TKF100A Outlet Turbidity Fault	WF-P0001						LCP-F01	DI	
0349	O	AI-F110A	Turbidity Indication	Filter TKF100A Outlet Turbidity	WF-P0001						LCP-F01	AI	
0350	O	AF-F110B	Particle Counter Fault	Filter TKF100A Outlet Particle Count Fault	WF-P0001						LCP-F01	DI	
0351	O	AI-F110B	Particle Counter Indication	Filter TKF100A Outlet Particle Count	WF-P0001						LCP-F01	AI	
0352	O	FA-F110A	Flow Alarm	Filter TKF100A Outlet Turbidity Sample Flow Low	WF-P0001						LCP-F01	DI	
0353	O	FA-F110B	Flow Alarm	Filter TKF100A Outlet Particle Count Sample Flow Low	WF-P0001						LCP-F01	DI	
0354	O	LF-F200A	Level Fault	Filter No. 2 Level Fault	WF-P0002						CP-H30	DI	
0355	O	LI-F200A	Level Indication	Filter No. 2 Level	WF-P0002						CP-H30	AI	
0356	O	PI-F200A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0002						LCP-F01	AI	
0357	O	YB-F201A	Close Command	Filter TKF200A Inlet Valve Close	WF-P0002						CP-H30	DO	
0358	O	YD-F201A	Open Command	Filter TKF200A Inlet Valve Open	WF-P0002						CP-H30	DO	
0359	O	YS-F201A	C/O/H Switch in Computer Position	Filter TKF200A Inlet Valve in Computer Mode	WF-P0002						CP-H30	DI	
0360	O	ZB-F201A	Closed Status	Filter TKF200A Inlet Valve Closed	WF-P0002						CP-H30	DI	
0361	O	ZD-F201A	Open Status	Filter TKF200A Inlet Valve Open	WF-P0002						CP-H30	DI	
0362	O	YB-F202A	Close Command	Filter TKF200A Backwash Water Outlet Valve Close	WF-P0002						CP-H30	DO	
0363	O	YD-F202A	Open Command	Filter TKF200A Backwash Water Outlet Valve Open	WF-P0002						CP-H30	DO	
0364	O	YS-F202A	C/O/H Switch in Computer Position	Filter TKF200A Backwash Water Outlet Valve in Computer Mode	WF-P0002						CP-H30	DI	
0365	O	ZB-F202A	Closed Status	Filter TKF200A Backwash Water Outlet Valve Closed	WF-P0002						CP-H30	DI	
0366	O	ZD-F202A	Open Status	Filter TKF200A Backwash Water Outlet Valve Open	WF-P0002						CP-H30	DI	
0367	O	FI-F203A	Flow Indication	Filter TKF200A Outlet Flow Rate	WF-P0002						LCP-F01	AI	
0368	O	FQ-F203A	Flow Pulse	Filter TKF200A Outlet Flow Total	WF-P0002						LCP-F01	DI	
0369	O	YS-F203A	C/O/H Switch in Computer Position	Filter TKF200A Outlet Flow Control Valve in Computer Mode	WF-P0002						LCP-F01	DI	
0370	O	ZB-F203A	Closed Status	Filter TKF200A Outlet Flow Control Valve Closed	WF-P0002						LCP-F01	DI	
0371	O	ZC-F203A	Position Control Output	Filter TKF200A Outlet Flow Control Valve Required Position	WF-P0002						LCP-F01	AO	
0372	O	ZD-F203A	Open Status	Filter TKF200A Outlet Flow Control Valve Open	WF-P0002						LCP-F01	DI	
0373	O	ZT-F203A	Position Feedback	Filter TKF200A Outlet Flow Control Valve Position	WF-P0002						LCP-F01	AI	
0374	O	YB-F204A	Close Command	Filter TKF200A Outlet Flow Valve Closed	WF-P0002						LCP-F01	DO	
0375	O	YD-F204A	Open Command	Filter TKF200A Outlet Flow Valve Open	WF-P0002						LCP-F01	DO	
0376	O	YS-F204A	C/O/H Switch in Computer Position	Filter TKF200A Outlet Flow Valve in Computer Mode	WF-P0002						LCP-F01	DI	
0377	O	ZB-F204A	Closed Status	Filter TKF200A Outlet Flow Valve Closed	WF-P0002						LCP-F01	DI	
0378	O	ZD-F204A	Open Status	Filter TKF200A Outlet Flow Valve Open	WF-P0002						LCP-F01	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0379	O	YB-F205A	Close Command	Filter TKF200A Outlet Flow to Backwash Tank Valve Close	WF-P0002						LCP-F01	DO	
0380	O	YD-F205A	Open Command	Filter TKF200A Outlet Flow to Backwash Tank Valve Open	WF-P0002						LCP-F01	DO	
0381	O	YS-F205A	C/O/H Switch in Computer Position	Filter TKF200A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0002						LCP-F01	DI	
0382	O	ZB-F205A	Closed Status	Filter TKF200A Outlet Flow to Backwash Tank Valve Closed	WF-P0002						LCP-F01	DI	
0383	O	ZD-F205A	Open Status	Filter TKF200A Outlet Flow to Backwash Tank Valve Open	WF-P0002						LCP-F01	DI	
0384	O	YB-F206A	Close Command	Filter TKF200A Backwash Water Inlet Valve Closed	WF-P0002						LCP-F01	DO	
0385	O	YD-F206A	Open Command	Filter TKF200A Backwash Water Inlet Valve Open	WF-P0002						LCP-F01	DO	
0386	O	YS-F206A	C/O/H Switch in Computer Position	Filter TKF200A Backwash Water Inlet Valve in Computer Mode	WF-P0002						LCP-F01	DI	
0387	O	ZB-F206A	Closed Status	Filter TKF200A Backwash Water Inlet Valve Closed	WF-P0002						LCP-F01	DI	
0388	O	ZD-F206A	Open Status	Filter TKF200A Backwash Water Inlet Valve Open	WF-P0002						LCP-F01	DI	
0389	O	YB-F207A	Close Command	Filter TKF200A Air Scour Valve Closed	WF-P0002						LCP-F01	DO	
0390	O	YD-F207A	Open Command	Filter TKF200A Air Scour Valve Open	WF-P0002						LCP-F01	DO	
0391	O	YS-F207A	C/O/H Switch in Computer Position	Filter TKF200A Air Scour Valve in Computer Mode	WF-P0002						LCP-F01	DI	
0392	O	ZB-F207A	Closed Status	Filter TKF200A Air Scour Valve Closed	WF-P0002						LCP-F01	DI	
0393	O	ZD-F207A	Open Status	Filter TKF200A Air Scour Valve Open	WF-P0002						LCP-F01	DI	
0394	O	AF-F210A	Turbidity Fault	Filter TKF200A Outlet Turbidity Fault	WF-P0002						LCP-F01	DI	
0395	O	AI-F210A	Turbidity Indication	Filter TKF200A Outlet Turbidity	WF-P0002						LCP-F01	AI	
0396	O	AF-F210B	Particle Counter Fault	Filter TKF200A Outlet Particle Count Fault	WF-P0002						LCP-F01	DI	
0397	O	AI-F210B	Particle Counter Indication	Filter TKF200A Outlet Particle Count	WF-P0002						LCP-F01	AI	
0398	O	FA-F210A	Flow Alarm	Filter TKF200A Outlet Turbidity Sample Flow Low	WF-P0002						LCP-F01	DI	
0399	O	FA-F210B	Flow Alarm	Filter TKF200A Outlet Particle Count Sample Flow Low	WF-P0002						LCP-F01	DI	
0400	O	LF-F300A	Level Fault	Filter No. 3 Level Fault	WF-P0003						CP-H30	DI	
0401	O	LI-F300A	Level Indication	Filter No. 3 Level	WF-P0003						CP-H30	AI	
0402	O	PI-F300A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0003						LCP-F01	AI	
0403	O	YB-F301A	Close Command	Filter TKF300A Inlet Valve Close	WF-P0003						CP-H30	DO	
0404	O	YD-F301A	Open Command	Filter TKF300A Inlet Valve Open	WF-P0003						CP-H30	DO	
0405	O	YS-F301A	C/O/H Switch in Computer Position	Filter TKF300A Inlet Valve in Computer Mode	WF-P0003						CP-H30	DI	
0406	O	ZB-F301A	Closed Status	Filter TKF300A Inlet Valve Closed	WF-P0003						CP-H30	DI	
0407	O	ZD-F301A	Open Status	Filter TKF300A Inlet Valve Open	WF-P0003						CP-H30	DI	
0408	O	YB-F302A	Close Command	Filter TKF300A Backwash Water Outlet Valve Close	WF-P0003						CP-H30	DO	
0409	O	YD-F302A	Open Command	Filter TKF300A Backwash Water Outlet Valve Open	WF-P0003						CP-H30	DO	
0410	O	YS-F302A	C/O/H Switch in Computer Position	Filter TKF300A Backwash Water Outlet Valve in Computer Mode	WF-P0003						CP-H30	DI	
0411	O	ZB-F302A	Closed Status	Filter TKF300A Backwash Water Outlet Valve Closed	WF-P0003						CP-H30	DI	
0412	O	ZD-F302A	Open Status	Filter TKF300A Backwash Water Outlet Valve Open	WF-P0003						CP-H30	DI	
0413	O	FI-F303A	Flow Indication	Filter TKF300A Outlet Flow Rate	WF-P0003						LCP-F01	AI	
0414	O	FQ-F303A	Flow Pulse	Filter TKF300A Outlet Flow Total	WF-P0003						LCP-F01	DI	
0415	O	YS-F303A	C/O/H Switch in Computer Position	Filter TKF300A Outlet Flow Control Valve in Computer Mode	WF-P0003						LCP-F01	DI	
0416	O	ZB-F303A	Closed Status	Filter TKF300A Outlet Flow Control Valve Closed	WF-P0003						LCP-F01	DI	
0417	O	ZC-F303A	Position Control Output	Filter TKF300A Outlet Flow Control Valve Required Position	WF-P0003						LCP-F01	AO	
0418	O	ZD-F303A	Open Status	Filter TKF300A Outlet Flow Control Valve Open	WF-P0003						LCP-F01	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0419	O	ZT-F303A	Position Feedback	Filter TKF300A Outlet Flow Control Valve Position	WF-P0003						LCP-F01	AI	
0420	O	YB-F304A	Close Command	Filter TKF300A Outlet Flow Valve Closed	WF-P0003						LCP-F01	DO	
0421	O	YD-F304A	Open Command	Filter TKF300A Outlet Flow Valve Open	WF-P0003						LCP-F01	DO	
0422	O	YS-F304A	C/O/H Switch in Computer Position	Filter TKF300A Outlet Flow Valve in Computer Mode	WF-P0003						LCP-F01	DI	
0423	O	ZB-F304A	Closed Status	Filter TKF300A Outlet Flow Valve Closed	WF-P0003						LCP-F01	DI	
0424	O	ZD-F304A	Open Status	Filter TKF300A Outlet Flow Valve Open	WF-P0003						LCP-F01	DI	
0425	O	YB-F305A	Close Command	Filter TKF300A Outlet Flow to Backwash Tank Valve Close	WF-P0003						LCP-F01	DO	
0426	O	YD-F305A	Open Command	Filter TKF300A Outlet Flow to Backwash Tank Valve Open	WF-P0003						LCP-F01	DO	
0427	O	YS-F305A	C/O/H Switch in Computer Position	Filter TKF300A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0003						LCP-F01	DI	
0428	O	ZB-F305A	Closed Status	Filter TKF300A Outlet Flow to Backwash Tank Valve Closed	WF-P0003						LCP-F01	DI	
0429	O	ZD-F305A	Open Status	Filter TKF300A Outlet Flow to Backwash Tank Valve Open	WF-P0003						LCP-F01	DI	
0430	O	YB-F306A	Close Command	Filter TKF300A Backwash Water Inlet Valve Closed	WF-P0003						LCP-F01	DO	
0431	O	YD-F306A	Open Command	Filter TKF300A Backwash Water Inlet Valve Open	WF-P0003						LCP-F01	DO	
0432	O	YS-F306A	C/O/H Switch in Computer Position	Filter TKF300A Backwash Water Inlet Valve in Computer Mode	WF-P0003						LCP-F01	DI	
0433	O	ZB-F306A	Closed Status	Filter TKF300A Backwash Water Inlet Valve Closed	WF-P0003						LCP-F01	DI	
0434	O	ZD-F306A	Open Status	Filter TKF300A Backwash Water Inlet Valve Open	WF-P0003						LCP-F01	DI	
0435	O	YB-F307A	Close Command	Filter TKF300A Air Scour Valve Closed	WF-P0003						LCP-F01	DO	
0436	O	YD-F307A	Open Command	Filter TKF300A Air Scour Valve Open	WF-P0003						LCP-F01	DO	
0437	O	YS-F307A	C/O/H Switch in Computer Position	Filter TKF300A Air Scour Valve in Computer Mode	WF-P0003						LCP-F01	DI	
0438	O	ZB-F307A	Closed Status	Filter TKF300A Air Scour Valve Closed	WF-P0003						LCP-F01	DI	
0439	O	ZD-F307A	Open Status	Filter TKF300A Air Scour Valve Open	WF-P0003						LCP-F01	DI	
0440	O	AF-F310A	Turbidity Fault	Filter TKF300A Outlet Turbidity Fault	WF-P0003						LCP-F01	DI	
0441	O	AI-F310A	Turbidity Indication	Filter TKF300A Outlet Turbidity	WF-P0003						LCP-F01	AI	
0442	O	AF-F310B	Particle Counter Fault	Filter TKF300A Outlet Particle Count Fault	WF-P0003						LCP-F01	DI	
0443	O	AI-F310B	Particle Counter Indication	Filter TKF300A Outlet Particle Count	WF-P0003						LCP-F01	AI	
0444	O	FA-F310A	Flow Alarm	Filter TKF300A Outlet Turbidity Sample Flow Low	WF-P0003						LCP-F01	DI	
0445	O	FA-F310B	Flow Alarm	Filter TKF300A Outlet Particle Count Sample Flow Low	WF-P0003						LCP-F01	DI	
0446	O	LF-F400A	Level Fault	Filter No. 4 Level Fault	WF-P0004						CP-H30	DI	
0447	O	LI-F400A	Level Indication	Filter No. 4 Level	WF-P0004						CP-H30	AI	
0448	O	PI-F400A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0004						LCP-F01	AI	
0449	O	YB-F401A	Close Command	Filter TKF400A Inlet Valve Close	WF-P0004						CP-H30	DO	
0450	O	YD-F401A	Open Command	Filter TKF400A Inlet Valve Open	WF-P0004						CP-H30	DO	
0451	O	YS-F401A	C/O/H Switch in Computer Position	Filter TKF400A Inlet Valve in Computer Mode	WF-P0004						CP-H30	DI	
0452	O	ZB-F401A	Closed Status	Filter TKF400A Inlet Valve Closed	WF-P0004						CP-H30	DI	
0453	O	ZD-F401A	Open Status	Filter TKF400A Inlet Valve Open	WF-P0004						CP-H30	DI	
0454	O	YB-F402A	Close Command	Filter TKF400A Backwash Water Outlet Valve Close	WF-P0004						CP-H30	DO	
0455	O	YD-F402A	Open Command	Filter TKF400A Backwash Water Outlet Valve Open	WF-P0004						CP-H30	DO	
0456	O	YS-F402A	C/O/H Switch in Computer Position	Filter TKF400A Backwash Water Outlet Valve in Computer Mode	WF-P0004						CP-H30	DI	
0457	O	ZB-F402A	Closed Status	Filter TKF400A Backwash Water Outlet Valve Closed	WF-P0004						CP-H30	DI	
0458	O	ZD-F402A	Open Status	Filter TKF400A Backwash Water Outlet Valve Open	WF-P0004						CP-H30	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0459	O	FI-F403A	Flow Indication	Filter TKF400A Outlet Flow Rate	WF-P0004						LCP-F01	AI	
0460	O	FQ-F403A	Flow Pulse	Filter TKF400A Outlet Flow Total	WF-P0004						LCP-F01	DI	
0461	O	YS-F403A	C/O/H Switch in Computer Position	Filter TKF400A Outlet Flow Control Valve in Computer Mode	WF-P0004						LCP-F01	DI	
0462	O	ZB-F403A	Closed Status	Filter TKF400A Outlet Flow Control Valve Closed	WF-P0004						LCP-F01	DI	
0463	O	ZC-F403A	Position Control Output	Filter TKF400A Outlet Flow Control Valve Required Position	WF-P0004						LCP-F01	AO	
0464	O	ZD-F403A	Open Status	Filter TKF400A Outlet Flow Control Valve Open	WF-P0004						LCP-F01	DI	
0465	O	ZT-F403A	Position Feedback	Filter TKF400A Outlet Flow Control Valve Position	WF-P0004						LCP-F01	AI	
0466	O	YB-F404A	Close Command	Filter TKF400A Outlet Flow Valve Closed	WF-P0004						LCP-F01	DO	
0467	O	YD-F404A	Open Command	Filter TKF400A Outlet Flow Valve Open	WF-P0004						LCP-F01	DO	
0468	O	YS-F404A	C/O/H Switch in Computer Position	Filter TKF400A Outlet Flow Valve in Computer Mode	WF-P0004						LCP-F01	DI	
0469	O	ZB-F404A	Closed Status	Filter TKF400A Outlet Flow Valve Closed	WF-P0004						LCP-F01	DI	
0470	O	ZD-F404A	Open Status	Filter TKF400A Outlet Flow Valve Open	WF-P0004						LCP-F01	DI	
0471	O	YB-F405A	Close Command	Filter TKF400A Outlet Flow to Backwash Tank Valve Close	WF-P0004						LCP-F01	DO	
0472	O	YD-F405A	Open Command	Filter TKF400A Outlet Flow to Backwash Tank Valve Open	WF-P0004						LCP-F01	DO	
0473	O	YS-F405A	C/O/H Switch in Computer Position	Filter TKF400A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0004						LCP-F01	DI	
0474	O	ZB-F405A	Closed Status	Filter TKF400A Outlet Flow to Backwash Tank Valve Closed	WF-P0004						LCP-F01	DI	
0475	O	ZD-F405A	Open Status	Filter TKF400A Outlet Flow to Backwash Tank Valve Open	WF-P0004						LCP-F01	DI	
0476	O	YB-F406A	Close Command	Filter TKF400A Backwash Water Inlet Valve Closed	WF-P0004						LCP-F01	DO	
0477	O	YD-F406A	Open Command	Filter TKF400A Backwash Water Inlet Valve Open	WF-P0004						LCP-F01	DO	
0478	O	YS-F406A	C/O/H Switch in Computer Position	Filter TKF400A Backwash Water Inlet Valve in Computer Mode	WF-P0004						LCP-F01	DI	
0479	O	ZB-F406A	Closed Status	Filter TKF400A Backwash Water Inlet Valve Closed	WF-P0004						LCP-F01	DI	
0480	O	ZD-F406A	Open Status	Filter TKF400A Backwash Water Inlet Valve Open	WF-P0004						LCP-F01	DI	
0481	O	YB-F407A	Close Command	Filter TKF400A Air Scour Valve Closed	WF-P0004						LCP-F01	DO	
0482	O	YD-F407A	Open Command	Filter TKF400A Air Scour Valve Open	WF-P0004						LCP-F01	DO	
0483	O	YS-F407A	C/O/H Switch in Computer Position	Filter TKF400A Air Scour Valve in Computer Mode	WF-P0004						LCP-F01	DI	
0484	O	ZB-F407A	Closed Status	Filter TKF400A Air Scour Valve Closed	WF-P0004						LCP-F01	DI	
0485	O	ZD-F407A	Open Status	Filter TKF400A Air Scour Valve Open	WF-P0004						LCP-F01	DI	
0486	O	AF-F410A	Turbidity Fault	Filter TKF400A Outlet Turbidity Fault	WF-P0004						LCP-F01	DI	
0487	O	AI-F410A	Turbidity Indication	Filter TKF400A Outlet Turbidity	WF-P0004						LCP-F01	AI	
0488	O	AF-F410B	Particle Counter Fault	Filter TKF400A Outlet Particle Count Fault	WF-P0004						LCP-F01	DI	
0489	O	AI-F410B	Particle Counter Indication	Filter TKF400A Outlet Particle Count	WF-P0004						LCP-F01	AI	
0490	O	FA-F410A	Flow Alarm	Filter TKF400A Outlet Turbidity Sample Flow Low	WF-P0004						LCP-F01	DI	
0491	O	FA-F410B	Flow Alarm	Filter TKF400A Outlet Particle Count Sample Flow Low	WF-P0004						LCP-F01	DI	
0492	O	LF-F500A	Level Fault	Filter No. 5 Level Fault	WF-P0005						CP-H30	DI	
0493	O	LI-F500A	Level Indication	Filter No. 5 Level	WF-P0005						CP-H30	AI	
0494	O	PI-F500A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0005						LCP-F02	AI	
0495	O	YB-F501A	Close Command	Filter TKF500A Inlet Valve Close	WF-P0005						CP-H30	DO	
0496	O	YD-F501A	Open Command	Filter TKF500A Inlet Valve Open	WF-P0005						CP-H30	DO	
0497	O	YS-F501A	C/O/H Switch in Computer Position	Filter TKF500A Inlet Valve in Computer Mode	WF-P0005						CP-H30	DI	
0498	O	ZB-F501A	Closed Status	Filter TKF500A Inlet Valve Closed	WF-P0005						CP-H30	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0499	O	ZD-F501A	Open Status	Filter TKF500A Inlet Valve Open	WF-P0005						CP-H30	DI	
0500	O	YB-F502A	Close Command	Filter TKF500A Backwash Water Outlet Valve Close	WF-P0005						CP-H30	DO	
0501	O	YD-F502A	Open Command	Filter TKF500A Backwash Water Outlet Valve Open	WF-P0005						CP-H30	DO	
0502	O	YS-F502A	C/O/H Switch in Computer Position	Filter TKF500A Backwash Water Outlet Valve in Computer Mode	WF-P0005						CP-H30	DI	
0503	O	ZB-F502A	Closed Status	Filter TKF500A Backwash Water Outlet Valve Closed	WF-P0005						CP-H30	DI	
0504	O	ZD-F502A	Open Status	Filter TKF500A Backwash Water Outlet Valve Open	WF-P0005						CP-H30	DI	
0505	O	FI-F503A	Flow Indication	Filter TKF500A Outlet Flow Rate	WF-P0005						LCP-F02	AI	
0506	O	FQ-F503A	Flow Pulse	Filter TKF500A Outlet Flow Total	WF-P0005						LCP-F02	DI	
0507	O	YS-F503A	C/O/H Switch in Computer Position	Filter TKF500A Outlet Flow Control Valve in Computer Mode	WF-P0005						LCP-F02	DI	
0508	O	ZB-F503A	Closed Status	Filter TKF500A Outlet Flow Control Valve Closed	WF-P0005						LCP-F02	DI	
0509	O	ZC-F503A	Position Control Output	Filter TKF500A Outlet Flow Control Valve Required Position	WF-P0005						LCP-F02	AO	
0510	O	ZD-F503A	Open Status	Filter TKF500A Outlet Flow Control Valve Open	WF-P0005						LCP-F02	DI	
0511	O	ZT-F503A	Position Feedback	Filter TKF500A Outlet Flow Control Valve Position	WF-P0005						LCP-F02	AI	
0512	O	YB-F504A	Close Command	Filter TKF500A Outlet Flow Valve Closed	WF-P0005						LCP-F02	DO	
0513	O	YD-F504A	Open Command	Filter TKF500A Outlet Flow Valve Open	WF-P0005						LCP-F02	DO	
0514	O	YS-F504A	C/O/H Switch in Computer Position	Filter TKF500A Outlet Flow Valve in Computer Mode	WF-P0005						LCP-F02	DI	
0515	O	ZB-F504A	Closed Status	Filter TKF500A Outlet Flow Valve Closed	WF-P0005						LCP-F02	DI	
0516	O	ZD-F504A	Open Status	Filter TKF500A Outlet Flow Valve Open	WF-P0005						LCP-F02	DI	
0517	O	YB-F505A	Close Command	Filter TKF500A Outlet Flow to Backwash Tank Valve Close	WF-P0005						LCP-F02	DO	
0518	O	YD-F505A	Open Command	Filter TKF500A Outlet Flow to Backwash Tank Valve Open	WF-P0005						LCP-F02	DO	
0519	O	YS-F505A	C/O/H Switch in Computer Position	Filter TKF500A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0005						LCP-F02	DI	
0520	O	ZB-F505A	Closed Status	Filter TKF500A Outlet Flow to Backwash Tank Valve Closed	WF-P0005						LCP-F02	DI	
0521	O	ZD-F505A	Open Status	Filter TKF500A Outlet Flow to Backwash Tank Valve Open	WF-P0005						LCP-F02	DI	
0522	O	YB-F506A	Close Command	Filter TKF500A Backwash Water Inlet Valve Closed	WF-P0005						LCP-F02	DO	
0523	O	YD-F506A	Open Command	Filter TKF500A Backwash Water Inlet Valve Open	WF-P0005						LCP-F02	DO	
0524	O	YS-F506A	C/O/H Switch in Computer Position	Filter TKF500A Backwash Water Inlet Valve in Computer Mode	WF-P0005						LCP-F02	DI	
0525	O	ZB-F506A	Closed Status	Filter TKF500A Backwash Water Inlet Valve Closed	WF-P0005						LCP-F02	DI	
0526	O	ZD-F506A	Open Status	Filter TKF500A Backwash Water Inlet Valve Open	WF-P0005						LCP-F02	DI	
0527	O	YB-F507A	Close Command	Filter TKF500A Air Scour Valve Closed	WF-P0005						LCP-F02	DO	
0528	O	YD-F507A	Open Command	Filter TKF500A Air Scour Valve Open	WF-P0005						LCP-F02	DO	
0529	O	YS-F507A	C/O/H Switch in Computer Position	Filter TKF500A Air Scour Valve in Computer Mode	WF-P0005						LCP-F02	DI	
0530	O	ZB-F507A	Closed Status	Filter TKF500A Air Scour Valve Closed	WF-P0005						LCP-F02	DI	
0531	O	ZD-F507A	Open Status	Filter TKF500A Air Scour Valve Open	WF-P0005						LCP-F02	DI	
0532	O	AF-F510A	Turbidity Fault	Filter TKF500A Outlet Turbidity Fault	WF-P0005						LCP-F02	DI	
0533	O	AI-F510A	Turbidity Indication	Filter TKF500A Outlet Turbidity	WF-P0005						LCP-F02	AI	
0534	O	AF-F510B	Particle Counter Fault	Filter TKF500A Outlet Particle Count Fault	WF-P0005						LCP-F02	DI	
0535	O	AI-F510B	Particle Counter Indication	Filter TKF500A Outlet Particle Count	WF-P0005						LCP-F02	AI	
0536	O	FA-F510A	Flow Alarm	Filter TKF500A Outlet Turbidity Sample Flow Low	WF-P0005						LCP-F02	DI	
0537	O	FA-F510B	Flow Alarm	Filter TKF500A Outlet Particle Count Sample Flow Low	WF-P0005						LCP-F02	DI	
0538	O	LF-F600A	Level Fault	Filter No. 6 Level Fault	WF-P0006						CP-H30	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0539	O	LI-F600A	Level Indication	Filter No. 6 Level	WF-P0006						CP-H30	AI	
0540	O	PI-F600A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0006						LCP-F02	AI	
0541	O	YB-F601A	Close Command	Filter TKF600A Inlet Valve Close	WF-P0006						CP-H30	DO	
0542	O	YD-F601A	Open Command	Filter TKF600A Inlet Valve Open	WF-P0006						CP-H30	DO	
0543	O	YS-F601A	C/O/H Switch in Computer Position	Filter TKF600A Inlet Valve in Computer Mode	WF-P0006						CP-H30	DI	
0544	O	ZB-F601A	Closed Status	Filter TKF600A Inlet Valve Closed	WF-P0006						CP-H30	DI	
0545	O	ZD-F601A	Open Status	Filter TKF600A Inlet Valve Open	WF-P0006						CP-H30	DI	
0546	O	YB-F602A	Close Command	Filter TKF600A Backwash Water Outlet Valve Close	WF-P0006						CP-H30	DO	
0547	O	YD-F602A	Open Command	Filter TKF600A Backwash Water Outlet Valve Open	WF-P0006						CP-H30	DO	
0548	O	YS-F602A	C/O/H Switch in Computer Position	Filter TKF600A Backwash Water Outlet Valve in Computer Mode	WF-P0006						CP-H30	DI	
0549	O	ZB-F602A	Closed Status	Filter TKF600A Backwash Water Outlet Valve Closed	WF-P0006						CP-H30	DI	
0550	O	ZD-F602A	Open Status	Filter TKF600A Backwash Water Outlet Valve Open	WF-P0006						CP-H30	DI	
0551	O	FI-F603A	Flow Indication	Filter TKF600A Outlet Flow Rate	WF-P0006						LCP-F02	AI	
0552	O	FQ-F603A	Flow Pulse	Filter TKF600A Outlet Flow Total	WF-P0006						LCP-F02	DI	
0553	O	YS-F603A	C/O/H Switch in Computer Position	Filter TKF600A Outlet Flow Control Valve in Computer Mode	WF-P0006						LCP-F02	DI	
0554	O	ZB-F603A	Closed Status	Filter TKF600A Outlet Flow Control Valve Closed	WF-P0006						LCP-F02	DI	
0555	O	ZC-F603A	Position Control Output	Filter TKF600A Outlet Flow Control Valve Required Position	WF-P0006						LCP-F02	AO	
0556	O	ZD-F603A	Open Status	Filter TKF600A Outlet Flow Control Valve Open	WF-P0006						LCP-F02	DI	
0557	O	ZT-F603A	Position Feedback	Filter TKF600A Outlet Flow Control Valve Position	WF-P0006						LCP-F02	AI	
0558	O	YB-F604A	Close Command	Filter TKF600A Outlet Flow Valve Closed	WF-P0006						LCP-F02	DO	
0559	O	YD-F604A	Open Command	Filter TKF600A Outlet Flow Valve Open	WF-P0006						LCP-F02	DO	
0560	O	YS-F604A	C/O/H Switch in Computer Position	Filter TKF600A Outlet Flow Valve in Computer Mode	WF-P0006						LCP-F02	DI	
0561	O	ZB-F604A	Closed Status	Filter TKF600A Outlet Flow Valve Closed	WF-P0006						LCP-F02	DI	
0562	O	ZD-F604A	Open Status	Filter TKF600A Outlet Flow Valve Open	WF-P0006						LCP-F02	DI	
0563	O	YB-F605A	Close Command	Filter TKF600A Outlet Flow to Backwash Tank Valve Close	WF-P0006						LCP-F02	DO	
0564	O	YD-F605A	Open Command	Filter TKF600A Outlet Flow to Backwash Tank Valve Open	WF-P0006						LCP-F02	DO	
0565	O	YS-F605A	C/O/H Switch in Computer Position	Filter TKF600A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0006						LCP-F02	DI	
0566	O	ZB-F605A	Closed Status	Filter TKF600A Outlet Flow to Backwash Tank Valve Closed	WF-P0006						LCP-F02	DI	
0567	O	ZD-F605A	Open Status	Filter TKF600A Outlet Flow to Backwash Tank Valve Open	WF-P0006						LCP-F02	DI	
0568	O	YB-F606A	Close Command	Filter TKF600A Backwash Water Inlet Valve Closed	WF-P0006						LCP-F02	DO	
0569	O	YD-F606A	Open Command	Filter TKF600A Backwash Water Inlet Valve Open	WF-P0006						LCP-F02	DO	
0570	O	YS-F606A	C/O/H Switch in Computer Position	Filter TKF600A Backwash Water Inlet Valve in Computer Mode	WF-P0006						LCP-F02	DI	
0571	O	ZB-F606A	Closed Status	Filter TKF600A Backwash Water Inlet Valve Closed	WF-P0006						LCP-F02	DI	
0572	O	ZD-F606A	Open Status	Filter TKF600A Backwash Water Inlet Valve Open	WF-P0006						LCP-F02	DI	
0573	O	YB-F607A	Close Command	Filter TKF600A Air Scour Valve Closed	WF-P0006						LCP-F02	DO	
0574	O	YD-F607A	Open Command	Filter TKF600A Air Scour Valve Open	WF-P0006						LCP-F02	DO	
0575	O	YS-F607A	C/O/H Switch in Computer Position	Filter TKF600A Air Scour Valve in Computer Mode	WF-P0006						LCP-F02	DI	
0576	O	ZB-F607A	Closed Status	Filter TKF600A Air Scour Valve Closed	WF-P0006						LCP-F02	DI	
0577	O	ZD-F607A	Open Status	Filter TKF600A Air Scour Valve Open	WF-P0006						LCP-F02	DI	
0578	O	AF-F610A	Turbidity Fault	Filter TKF600A Outlet Turbidity Fault	WF-P0006						LCP-F02	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0579	O	AI-F610A	Turbidity Indication	Filter TKF600A Outlet Turbidity	WF-P0006						LCP-F02	AI	
0580	O	AF-F610B	Particle Counter Fault	Filter TKF600A Outlet Particle Count Fault	WF-P0006						LCP-F02	DI	
0581	O	AI-F610B	Particle Counter Indication	Filter TKF600A Outlet Particle Count	WF-P0006						LCP-F02	AI	
0582	O	FA-F610A	Flow Alarm	Filter TKF600A Outlet Turbidity Sample Flow Low	WF-P0006						LCP-F02	DI	
0583	O	FA-F610B	Flow Alarm	Filter TKF600A Outlet Particle Count Sample Flow Low	WF-P0006						LCP-F02	DI	
0584	O	LF-F700A	Level Fault	Filter No. 7 Level Fault	WF-P0007						CP-H30	DI	
0585	O	LI-F700A	Level Indication	Filter No. 7 Level	WF-P0007						CP-H30	AI	
0586	O	PI-F700A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0007						LCP-F02	AI	
0587	O	YB-F701A	Close Command	Filter TKF700A Inlet Valve Close	WF-P0007						CP-H30	DO	
0588	O	YD-F701A	Open Command	Filter TKF700A Inlet Valve Open	WF-P0007						CP-H30	DO	
0589	O	YS-F701A	C/O/H Switch in Computer Position	Filter TKF700A Inlet Valve in Computer Mode	WF-P0007						CP-H30	DI	
0590	O	ZB-F701A	Closed Status	Filter TKF700A Inlet Valve Closed	WF-P0007						CP-H30	DI	
0591	O	ZD-F701A	Open Status	Filter TKF700A Inlet Valve Open	WF-P0007						CP-H30	DI	
0592	O	YB-F702A	Close Command	Filter TKF700A Backwash Water Outlet Valve Close	WF-P0007						CP-H30	DO	
0593	O	YD-F702A	Open Command	Filter TKF700A Backwash Water Outlet Valve Open	WF-P0007						CP-H30	DO	
0594	O	YS-F702A	C/O/H Switch in Computer Position	Filter TKF700A Backwash Water Outlet Valve in Computer Mode	WF-P0007						CP-H30	DI	
0595	O	ZB-F702A	Closed Status	Filter TKF700A Backwash Water Outlet Valve Closed	WF-P0007						CP-H30	DI	
0596	O	ZD-F702A	Open Status	Filter TKF700A Backwash Water Outlet Valve Open	WF-P0007						CP-H30	DI	
0597	O	FI-F703A	Flow Indication	Filter TKF700A Outlet Flow Rate	WF-P0007						LCP-F02	AI	
0598	O	FQ-F703A	Flow Pulse	Filter TKF700A Outlet Flow Total	WF-P0007						LCP-F02	DI	
0599	O	YS-F703A	C/O/H Switch in Computer Position	Filter TKF700A Outlet Flow Control Valve in Computer Mode	WF-P0007						LCP-F02	DI	
0600	O	ZB-F703A	Closed Status	Filter TKF700A Outlet Flow Control Valve Closed	WF-P0007						LCP-F02	DI	
0601	O	ZC-F703A	Position Control Output	Filter TKF700A Outlet Flow Control Valve Required Position	WF-P0007						LCP-F02	AO	
0602	O	ZD-F703A	Open Status	Filter TKF700A Outlet Flow Control Valve Open	WF-P0007						LCP-F02	DI	
0603	O	ZT-F703A	Position Feedback	Filter TKF700A Outlet Flow Control Valve Position	WF-P0007						LCP-F02	AI	
0604	O	YB-F704A	Close Command	Filter TKF700A Outlet Flow Valve Closed	WF-P0007						LCP-F02	DO	
0605	O	YD-F704A	Open Command	Filter TKF700A Outlet Flow Valve Open	WF-P0007						LCP-F02	DO	
0606	O	YS-F704A	C/O/H Switch in Computer Position	Filter TKF700A Outlet Flow Valve in Computer Mode	WF-P0007						LCP-F02	DI	
0607	O	ZB-F704A	Closed Status	Filter TKF700A Outlet Flow Valve Closed	WF-P0007						LCP-F02	DI	
0608	O	ZD-F704A	Open Status	Filter TKF700A Outlet Flow Valve Open	WF-P0007						LCP-F02	DI	
0609	O	YB-F705A	Close Command	Filter TKF700A Outlet Flow to Backwash Tank Valve Close	WF-P0007						LCP-F02	DO	
0610	O	YD-F705A	Open Command	Filter TKF700A Outlet Flow to Backwash Tank Valve Open	WF-P0007						LCP-F02	DO	
0611	O	YS-F705A	C/O/H Switch in Computer Position	Filter TKF700A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0007						LCP-F02	DI	
0612	O	ZB-F705A	Closed Status	Filter TKF700A Outlet Flow to Backwash Tank Valve Closed	WF-P0007						LCP-F02	DI	
0613	O	ZD-F705A	Open Status	Filter TKF700A Outlet Flow to Backwash Tank Valve Open	WF-P0007						LCP-F02	DI	
0614	O	YB-F706A	Close Command	Filter TKF700A Backwash Water Inlet Valve Closed	WF-P0007						LCP-F02	DO	
0615	O	YD-F706A	Open Command	Filter TKF700A Backwash Water Inlet Valve Open	WF-P0007						LCP-F02	DO	
0616	O	YS-F706A	C/O/H Switch in Computer Position	Filter TKF700A Backwash Water Inlet Valve in Computer Mode	WF-P0007						LCP-F02	DI	
0617	O	ZB-F706A	Closed Status	Filter TKF700A Backwash Water Inlet Valve Closed	WF-P0007						LCP-F02	DI	
0618	O	ZD-F706A	Open Status	Filter TKF700A Backwash Water Inlet Valve Open	WF-P0007						LCP-F02	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0619	O	YB-F707A	Close Command	Filter TKF700A Air Scour Valve Closed	WF-P0007						LCP-F02	DO	
0620	O	YD-F707A	Open Command	Filter TKF700A Air Scour Valve Open	WF-P0007						LCP-F02	DO	
0621	O	YS-F707A	C/O/H Switch in Computer Position	Filter TKF700A Air Scour Valve in Computer Mode	WF-P0007						LCP-F02	DI	
0622	O	ZB-F707A	Closed Status	Filter TKF700A Air Scour Valve Closed	WF-P0007						LCP-F02	DI	
0623	O	ZD-F707A	Open Status	Filter TKF700A Air Scour Valve Open	WF-P0007						LCP-F02	DI	
0624	O	AF-F710A	Turbidity Fault	Filter TKF700A Outlet Turbidity Fault	WF-P0007						LCP-F02	DI	
0625	O	AI-F710A	Turbidity Indication	Filter TKF700A Outlet Turbidity	WF-P0007						LCP-F02	AI	
0626	O	AF-F710B	Particle Counter Fault	Filter TKF700A Outlet Particle Count Fault	WF-P0007						LCP-F02	DI	
0627	O	AI-F710B	Particle Counter Indication	Filter TKF700A Outlet Particle Count	WF-P0007						LCP-F02	AI	
0628	O	FA-F710A	Flow Alarm	Filter TKF700A Outlet Turbidity Sample Flow Low	WF-P0007						LCP-F02	DI	
0629	O	FA-F710B	Flow Alarm	Filter TKF700A Outlet Particle Count Sample Flow Low	WF-P0007						LCP-F02	DI	
0630	O	LF-F800A	Level Fault	Filter No. 8 Level Fault	WF-P0008						CP-H30	DI	
0631	O	LI-F800A	Level Indication	Filter No. 8 Level	WF-P0008						CP-H30	AI	
0632	O	PI-F800A	Differential Pressure Indication	Overall Filter Differential Pressure	WF-P0008						LCP-F02	AI	
0633	O	YB-F801A	Close Command	Filter TKF800A Inlet Valve Close	WF-P0008						CP-H30	DO	
0634	O	YD-F801A	Open Command	Filter TKF800A Inlet Valve Open	WF-P0008						CP-H30	DO	
0635	O	YS-F801A	C/O/H Switch in Computer Position	Filter TKF800A Inlet Valve in Computer Mode	WF-P0008						CP-H30	DI	
0636	O	ZB-F801A	Closed Status	Filter TKF800A Inlet Valve Closed	WF-P0008						CP-H30	DI	
0637	O	ZD-F801A	Open Status	Filter TKF800A Inlet Valve Open	WF-P0008						CP-H30	DI	
0638	O	YB-F802A	Close Command	Filter TKF800A Backwash Water Outlet Valve Close	WF-P0008						CP-H30	DO	
0639	O	YD-F802A	Open Command	Filter TKF800A Backwash Water Outlet Valve Open	WF-P0008						CP-H30	DO	
0640	O	YS-F802A	C/O/H Switch in Computer Position	Filter TKF800A Backwash Water Outlet Valve in Computer Mode	WF-P0008						CP-H30	DI	
0641	O	ZB-F802A	Closed Status	Filter TKF800A Backwash Water Outlet Valve Closed	WF-P0008						CP-H30	DI	
0642	O	ZD-F802A	Open Status	Filter TKF800A Backwash Water Outlet Valve Open	WF-P0008						CP-H30	DI	
0643	O	FI-F803A	Flow Indication	Filter TKF800A Outlet Flow Rate	WF-P0008						LCP-F02	AI	
0644	O	FQ-F803A	Flow Pulse	Filter TKF800A Outlet Flow Total	WF-P0008						LCP-F02	DI	
0645	O	YS-F803A	C/O/H Switch in Computer Position	Filter TKF800A Outlet Flow Control Valve in Computer Mode	WF-P0008						LCP-F02	DI	
0646	O	ZB-F803A	Closed Status	Filter TKF800A Outlet Flow Control Valve Closed	WF-P0008						LCP-F02	DI	
0647	O	ZC-F803A	Position Control Output	Filter TKF800A Outlet Flow Control Valve Required Position	WF-P0008						LCP-F02	AO	
0648	O	ZD-F803A	Open Status	Filter TKF800A Outlet Flow Control Valve Open	WF-P0008						LCP-F02	DI	
0649	O	ZT-F803A	Position Feedback	Filter TKF800A Outlet Flow Control Valve Position	WF-P0008						LCP-F02	AI	
0650	O	YB-F804A	Close Command	Filter TKF800A Outlet Flow Valve Closed	WF-P0008						LCP-F02	DO	
0651	O	YD-F804A	Open Command	Filter TKF800A Outlet Flow Valve Open	WF-P0008						LCP-F02	DO	
0652	O	YS-F804A	C/O/H Switch in Computer Position	Filter TKF800A Outlet Flow Valve in Computer Mode	WF-P0008						LCP-F02	DI	
0653	O	ZB-F804A	Closed Status	Filter TKF800A Outlet Flow Valve Closed	WF-P0008						LCP-F02	DI	
0654	O	ZD-F804A	Open Status	Filter TKF800A Outlet Flow Valve Open	WF-P0008						LCP-F02	DI	
0655	O	YB-F805A	Close Command	Filter TKF800A Outlet Flow to Backwash Tank Valve Close	WF-P0008						LCP-F02	DO	
0656	O	YD-F805A	Open Command	Filter TKF800A Outlet Flow to Backwash Tank Valve Open	WF-P0008						LCP-F02	DO	
0657	O	YS-F805A	C/O/H Switch in Computer Position	Filter TKF800A Outlet Flow to Backwash Tank Valve in Computer Mode	WF-P0008						LCP-F02	DI	
0658	O	ZB-F805A	Closed Status	Filter TKF800A Outlet Flow to Backwash Tank Valve Closed	WF-P0008						LCP-F02	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0659	O	ZD-F805A	Open Status	Filter TKF800A Outlet Flow to Backwash Tank Valve Open	WF-P0008						LCP-F02	DI	
0660	O	YB-F806A	Close Command	Filter TKF800A Backwash Water Inlet Valve Closed	WF-P0008						LCP-F02	DO	
0661	O	YD-F806A	Open Command	Filter TKF800A Backwash Water Inlet Valve Open	WF-P0008						LCP-F02	DO	
0662	O	YS-F806A	C/O/H Switch in Computer Position	Filter TKF800A Backwash Water Inlet Valve in Computer Mode	WF-P0008						LCP-F02	DI	
0663	O	ZB-F806A	Closed Status	Filter TKF800A Backwash Water Inlet Valve Closed	WF-P0008						LCP-F02	DI	
0664	O	ZD-F806A	Open Status	Filter TKF800A Backwash Water Inlet Valve Open	WF-P0008						LCP-F02	DI	
0665	O	YB-F807A	Close Command	Filter TKF800A Air Scour Valve Closed	WF-P0008						LCP-F02	DO	
0666	O	YD-F807A	Open Command	Filter TKF800A Air Scour Valve Open	WF-P0008						LCP-F02	DO	
0667	O	YS-F807A	C/O/H Switch in Computer Position	Filter TKF800A Air Scour Valve in Computer Mode	WF-P0008						LCP-F02	DI	
0668	O	ZB-F807A	Closed Status	Filter TKF800A Air Scour Valve Closed	WF-P0008						LCP-F02	DI	
0669	O	ZD-F807A	Open Status	Filter TKF800A Air Scour Valve Open	WF-P0008						LCP-F02	DI	
0670	O	AF-F810A	Turbidity Fault	Filter TKF800A Outlet Turbidity Fault	WF-P0008						LCP-F02	DI	
0671	O	AI-F810A	Turbidity Indication	Filter TKF800A Outlet Turbidity	WF-P0008						LCP-F02	AI	
0672	O	AF-F810B	Particle Counter Fault	Filter TKF800A Outlet Particle Count Fault	WF-P0008						LCP-F02	DI	
0673	O	AI-F810B	Particle Counter Indication	Filter TKF800A Outlet Particle Count	WF-P0008						LCP-F02	AI	
0674	O	FA-F810A	Flow Alarm	Filter TKF800A Outlet Turbidity Sample Flow Low	WF-P0008						LCP-F02	DI	
0675	O	FA-F810B	Flow Alarm	Filter TKF800A Outlet Particle Count Sample Flow Low	WF-P0008						LCP-F02	DI	
0676	O	LI-F910A	Level Indicator Transmitter	Backwash Tank TNKF910A Level	WF-P0009						LCP-F01	AI	
0677	O	YB-F910A	Close Command	Backwash Tank TNKF910A Outlet Valve Close	WF-P0009						LCP-F01	DO	
0678	O	YD-F910A	Open Command	Backwash Tank TNKF910A Outlet Valve Open	WF-P0009						LCP-F01	DO	
0679	O	YS-F910A	C/O/H Switch in Computer Position	Backwash Tank TNKF910A Outlet Valve in Computer Mode	WF-P0009						LCP-F01	DI	
0680	O	ZB-F910A	Closed Status	Backwash Tank TNKF910A Outlet Valve Close	WF-P0009						LCP-F01	DI	
0681	O	ZD-F910A	Open Status	Backwash Tank TNKF910A Outlet Valve Open	WF-P0009						LCP-F01	DI	
0682	O	FI-F911A	Flow Indication	Filter Backwash Pump P-F911A Outlet Flow Rate	WF-P0009						LCP-F01	AI	
0683	O	FQ-F911A	Flow Pulse	Filter Backwash Pump P-F911A Outlet Flow Total	WF-P0009						LCP-F01	DI	
0684	O	IT-F911A	Current Indication	Filter Backwash Pump P-F911A Current	WF-P0013						LCP-H10	AI TCP	
0685	O	MM-F911A	Running Status	Filter Backwash Pump P-F911A Running	WF-P0013						LCP-H10	DI TCP	
0686	O	MN-F911A	Start Command	Filter Backwash Pump P-F911A Start	WF-P0013						LCP-H10	DO TCP	
0687	O	PI-F911A	Pressure Indication	Filter Backwash Pump P-F911A Outlet Pressure	WF-P0009						LCP-F01	AI	
0688	O	SC-F911A	Speed Control Output	Filter Backwash Pump P-F911A Required Speed	WF-P0013						LCP-H10	AO TCP	
0689	O	SI-F911A	Speed Indication	Filter Backwash Pump P-F911A Speed	WF-P0013						LCP-H10	AI TCP	
0690	O	TI-F911A	Temperature Indicator Transmitter	Filter Backwash Pump P-F911A Outlet Temperature	WF-P0009						LCP-F01	AI	
0691	O	TI-F911A	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0692	O	TI-F911B	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0693	O	TI-F911C	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0694	O	TI-F911D	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0695	O	TI-F911E	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0696	O	TI-F911F	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0697	O	TI-F911G	Temperature Transmitter	Filter Backwash Pump P-F911A Front Bearing Temperature	WF-P0013						LCP-H10	AI TCP	
0698	O	TI-F911H	Temperature Transmitter	Filter Backwash Pump P-F911A Back Bearing Temperature	WF-P0013						LCP-H10	AI TCP	
0699	O	UF-F911A	No Fault	Filter Backwash Pump P-F911A VFD Fault	WF-P0013						LCP-H10	DI TCP	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0700	O	UF-F911B	No Fault	Filter Backwash Pump P-F911A Protection Relay Fault	WF-P0013						LCP-H10	DI TCP	
0701	O	YS-F911A	C/O/H Switch in Computer Position	Filter Backwash Pump P-F911A Outlet Control Valve in Computer Mode	WF-P0009						LCP-F01	DI	
0702	O	YS-F911A	C/O/H Switch in Computer Position	Filter Backwash Pump P-F911A in Computer Mode	WF-P0013						LCP-H10	DI TCP	
0703	O	ZB-F911A	Closed Status	Filter Backwash Pump P-F911A Outlet Control Valve Closed	WF-P0009						LCP-F01	DI	
0704	O	ZC-F911A	Position Control Output	Filter Backwash Pump P-F911A Outlet Control Valve Position	WF-P0009						LCP-F01	AO	
0705	O	ZD-F911A	Open Status	Filter Backwash Pump P-F911A Outlet Control Valve Open	WF-P0009						LCP-F01	DI	
0706	O	ZT-F911A	Position Feedback	Filter Backwash Pump P-F911A Outlet Control Valve Required Position	WF-P0009						LCP-F01	AI	
0707	O	YB-F912A	Close Command	Backwash Tank TNKF910A Inlet Valve Close	WF-P0009						LCP-F01	DO	
0708	O	YD-F912A	Open Command	Backwash Tank TNKF910A Inlet Valve Open	WF-P0009						LCP-F01	DO	
0709	O	YS-F912A	C/O/H Switch in Computer Position	Backwash Tank TNKF910A Inlet Valve in Computer Mode	WF-P0009						LCP-F01	DI	
0710	O	ZB-F912A	Closed Status	Backwash Tank TNKF910A Inlet Valve Closed	WF-P0009						LCP-F01	DI	
0711	O	ZD-F912A	Open Status	Backwash Tank TNKF910A Inlet Valve Open	WF-P0009						LCP-F01	DI	
0712	O	LI-F920A	Level Indicator Transmitter	Backwash Tank TNKF920A Level	WF-P0009						LCP-F02	AI	
0713	O	YB-F920A	Close Command	Backwash Tank TNKF920A Outlet Valve Close	WF-P0009						LCP-F02	DO	
0714	O	YD-F920A	Open Command	Backwash Tank TNKF920A Outlet Valve Open	WF-P0009						LCP-F02	DO	
0715	O	YS-F920A	C/O/H Switch in Computer Position	Backwash Tank TNKF920A Outlet Valve in Computer Mode	WF-P0009						LCP-F02	DI	
0716	O	ZB-F920A	Closed Status	Backwash Tank TNKF920A Outlet Valve Closed	WF-P0009						LCP-F02	DI	
0717	O	ZD-F920A	Open Status	Backwash Tank TNKF920A Outlet Valve Open	WF-P0009						LCP-F02	DI	
0718	O	FI-F921A	Flow Indication	Filter Backwash Pump P-F921A Outlet Flow Rate	WF-P0009						LCP-F02	AI	
0719	O	FQ-F921A	Flow Pulse	Filter Backwash Pump P-F921A Outlet Flow Total	WF-P0009						LCP-F02	DI	
0720	O	IT-F921A	Current Indication	Filter Backwash Pump P-F921A Current	WF-P0013						LCP-H10	AI TCP	
0721	O	MM-F921A	Running Status	Filter Backwash Pump P-F921A Running	WF-P0013						LCP-H10	DI TCP	
0722	O	MN-F921A	Start Command	Filter Backwash Pump P-F921A Start	WF-P0013						LCP-H10	DO TCP	
0723	O	PI-F921A	Pressure Indication	Filter Backwash Pump P-F921A Outlet Pressure	WF-P0009						LCP-F02	AI	
0724	O	SC-F921A	Speed Control Output	Filter Backwash Pump P-F921A Required Speed	WF-P0013						LCP-H10	AO TCP	
0725	O	SI-F921A	Speed Indication	Filter Backwash Pump P-F921A Speed	WF-P0013						LCP-H10	AI TCP	
0726	O	TI-F921A	Temperature Indication	Filter Backwash Pump P-F921 Outlet Temperature	WF-P0009						LCP-F02	AI	
0727	O	TT-F921A	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0728	O	TT-F921B	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0729	O	TT-F921C	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0730	O	TT-F921D	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0731	O	TT-F921E	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0732	O	TT-F921F	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature	WF-P0013						LCP-H10	AI TCP	
0733	O	TT-F921G	Temperature Transmitter	Filter Backwash Pump P-F921A Front Bearing Temperature	WF-P0013						LCP-H10	AI TCP	
0734	O	TT-F921H	Temperature Transmitter	Filter Backwash Pump P-F921A Back Bearing Temperature	WF-P0013						LCP-H10	AI TCP	
0735	O	UF-F921A	No Fault	Filter Backwash Pump P-F921A VFDFault	WF-P0013						LCP-H10	DI TCP	
0736	O	UF-F921B	No Fault	Filter Backwash Pump P-F921A Protection RelayFault	WF-P0013						LCP-H10	DI TCP	
0737	O	YS-F921A	C/O/H Switch in Computer Position	Filter Backwash Pump P-F921A Outlet Control Valve in Computer Mode	WF-P0009						LCP-F02	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0738	O	YS-F921A	C/O/H Switch in Computer Position	Filter Backwash Pump P-F921A in Computer Mode	WF-P0013						LCP-H10	DI TCP	
0739	O	ZB-F921A	Closed Status	Filter Backwash Pump P-F921A Outlet Control Valve Closed	WF-P0009						LCP-F02	DI	
0740	O	ZC-F921A	Position Control Output	Filter Backwash Pump P-F921A Outlet Control Valve Required Position	WF-P0009						LCP-F02	AO	
0741	O	ZD-F921A	Open Status	Filter Backwash Pump P-F921A Outlet Control Valve Open	WF-P0009						LCP-F02	DI	
0742	O	ZT-F921A	Position Feedback	Filter Backwash Pump P-F921A Outlet Control Valve Position	WF-P0009						LCP-F02	AI	
0743	O	YB-F922A	Close Command	Backwash Tank TNKF920A Inlet Valve Close	WF-P0009						LCP-F02	DO	
0744	O	YD-F922A	Open Command	Backwash Tank TNKF920A Inlet Valve Open	WF-P0009						LCP-F02	DO	
0745	O	YS-F922A	C/O/H Switch in Computer Position	Backwash Tank TNKF920A Inlet Valve in Computer Mode	WF-P0009						LCP-F02	DI	
0746	O	ZB-F922A	Closed Status	Backwash Tank TNKF920A Inlet Valve Closed	WF-P0009						LCP-F02	DI	
0747	O	ZD-F922A	Open Status	Backwash Tank TNKF920A Inlet Valve Open	WF-P0009						LCP-F02	DI	
0748	O	YB-F931A	Close Command	Backwash Tank Inlet Crossover Valve Close	WF-P0009						LCP-F02	DO	
0749	O	YD-F931A	Open Command	Backwash Tank Inlet Crossover Valve Open	WF-P0009						LCP-F02	DO	
0750	O	YS-F931A	C/O/H Switch in Computer Position	Backwash Tank Inlet Crossover Valve in Computer Mode	WF-P0009						LCP-F02	DI	
0751	O	ZB-F931A	Closed Status	Backwash Tank Inlet Crossover Valve Closed	WF-P0009						LCP-F02	DI	
0752	O	ZD-F931A	Open Status	Backwash Tank Inlet Crossover Valve Open	WF-P0009						LCP-F02	DI	
0753	O	YB-F932A	Close Command	Backwash Tank Inlet Crossover Valve Close	WF-P0009						LCP-F02	DO	
0754	O	YD-F932A	Open Command	Backwash Tank Inlet Crossover Valve Open	WF-P0009						LCP-F02	DO	
0755	O	YS-F932A	C/O/H Switch in Computer Position	Backwash Tank Inlet Crossover Valve in Computer Mode	WF-P0009						LCP-F02	DI	
0756	O	ZB-F932A	Closed Status	Backwash Tank Inlet Crossover Valve Closed	WF-P0009						LCP-F02	DI	
0757	O	ZD-F932A	Open Status	Backwash Tank Inlet Crossover Valve Open	WF-P0009						LCP-F02	DI	
0758	O	YB-F933A	Close Command	Backwash Pump Outlet Crossover Valve Close	WF-P0009						LCP-F01	DO	
0759	O	YD-F933A	Open Command	Backwash Pump Outlet Crossover Valve Open	WF-P0009						LCP-F01	DO	
0760	O	YS-F933A	C/O/H Switch in Computer Position	Backwash Pump Outlet Crossover Valve in Computer Mode	WF-P0009						LCP-F01	DI	
0761	O	ZB-F933A	Closed Status	Backwash Pump Outlet Crossover Valve Closed	WF-P0009						LCP-F01	DI	
0762	O	ZD-F933A	Open Status	Backwash Pump Outlet Crossover Valve Open	WF-P0009						LCP-F01	DI	
0763	O	LF-F980A	Level Fault	Backwash Area Process Sump Pump Level	WF-P0012						LCP-F01	DI	
0764	O	LI-F980A	Level Indication	Backwash Area Process Sump Pump Level	WF-P0012						LCP-F01	AI	
0765	O	LF-F980B	Level Fault	Backwash Area Process Sump Pump Level	WF-P0012						LCP-F01	DI	
0766	O	LI-F980B	Level Indication	Backwash Area Process Sump Pump Level	WF-P0012						LCP-F01	AI	
0767	O	MM-F981A	Running Status	Backwash Area Process Sump Pump P-F981A to Floodway Running	WF-P0012						LCP-F01	DI	
0768	O	MN-F981A	Start Command	Backwash Area Process Sump Pump P-F981A to Floodway Start	WF-P0012						LCP-F01	DO	
0769	O	UF-F981A	No Fault	Backwash Area Process Sump Pump P-F981A to Floodway Fault	WF-P0012						LCP-F01	DI	
0770	O	YS-F981A	C/O/H Switch in Computer Position	Backwash Area Process Sump Pump P-F981A to Floodway in Computer Mode	WF-P0012						LCP-F01	DI	
0771	O	MM-F982A	Running Status	Backwash Area Process Sump Pump P-F982A to Floodway Running	WF-P0012						LCP-F01	DI	
0772	O	MN-F982A	Start Command	Backwash Area Process Sump Pump P-F982A to Floodway Start	WF-P0012						LCP-F01	DO	
0773	O	UF-F982A	No Fault	Backwash Area Process Sump Pump P-F982A to Floodway Fault	WF-P0012						LCP-F01	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0774	O	YS-F982A	C/O/H Switch in Computer Position	Backwash Area Process Sump Pump P-F982A to Floodway in Computer Mode	WF-P0012						LCP-F01	DI	
0775	O	MM-F983A	Running Status	Backwash Area Process Sump Pump P-F983A to Floodway Running	WF-P0012						LCP-F01	DI	
0776	O	MN-F983A	Start Command	Backwash Area Process Sump Pump P-F983A to Floodway Start	WF-P0012						LCP-F01	DO	
0777	O	UF-F983A	No Fault	Backwash Area Process Sump Pump P-F983A to Floodway Fault	WF-P0012						LCP-F01	DI	
0778	O	YS-F983A	C/O/H Switch in Computer Position	Backwash Area Process Sump Pump P-F983A to Floodway in Computer Mode	WF-P0012						LCP-F01	DI	
0779	O	LA-F984A	Level Alarm	Backwash Area Process Sump Pump P-F984A Stop Level	WF-P0012						LCP-F01	DI	
0780	O	LA-F984B	Level Alarm	Backwash Area Process Sump Pump P-F984A Start Level	WF-P0012						LCP-F01	DI	
0781	O	MM-F984A	Running Status	Backwash Area Process Sump Pump P-F984A to Sanitary Sump Running	WF-P0012						LCP-F01	DI	
0782	O	MN-F984A	Start Command	Backwash Area Process Sump Pump P-F984A to Sanitary Sump Start	WF-P0012						LCP-F01	DO	
0783	O	UF-F984A	No Fault	Backwash Area Process Sump Pump P-F984A to Sanitary Sump Fault	WF-P0012						LCP-F01	DI	
0784	O	YS-F984A	C/O/H Switch in Computer Position	Backwash Area Process Sump Pump P-F984A to Sanitary Sump in Computer Mode	WF-P0012						LCP-F01	DI	
0785	O	LA-I000A	Level Switch	Raw Water Pumping Station Low Low Level	WI-P0001						LCP-H10	DI	
0786	O	LF-I000A	No Fault	Raw Water Pumping Station Level No Fault	WI-P0001						LCP-H10	DI	
0787	O	LI-I000A	Level Indication	Raw Water Pumping Station Level	WI-P0001						LCP-H10	AI	
0788	O	LA-I000C	Level Switch	Raw Water Pumping Station High High Level	WI-P0001						LCP-H10	DI	
0789	O	LA-I000B	Level Switch	Raw Water Pumping Station Low Low Level	WI-P0002						LCP-H10	DI	
0790	O	LF-I000B	No Fault	Raw Water Pumping Station Level No Fault	WI-P0002						LCP-H10	DI	
0791	O	LI-I000B	Level Indication	Raw Water Pumping Station Level	WI-P0002						LCP-H10	AI	
0792	O	LA-I000D	Level Switch	Raw Water Pumping Station High High Level	WI-P0002						LCP-H10	DI	
0793	O	YB-I000A	Close Command	Raw Water Pumping Station Inlet Valve Close	WI-P0001						LCP-H10	DO	
0794	O	YD-I000A	Open Command	Raw Water Pumping Station Inlet Valve Open	WI-P0001						LCP-H10	DO	
0795	O	YS-I000A	C/O/H Switch in Computer Position	Raw Water Pumping Station Inlet Valve in Comp Mode	WI-P0001						LCP-H10	DI	
0796	O	YB-I000C	Close Command	Raw Water Pumping Station Dividing Wall Sluice Gate Close	WI-P0001						LCP-H10	DO	
0797	O	YD-I000C	Open Command	Raw Water Pumping Station Dividing Wall Sluice Gate Open	WI-P0001						LCP-H10	DO	
0798	O	YS-I000C	C/O/H Switch in Computer Position	Raw Water Pumping Station Dividing Wall Sluice Gate in Comp Mode	WI-P0001						LCP-H10	DI	
0799	O	YB-I000B	Close Command	Raw Water Pumping Station Inlet Valve Close	WI-P0002						LCP-H10	DO	
0800	O	YD-I000B	Open Command	Raw Water Pumping Station Inlet Valve Open	WI-P0002						LCP-H10	DO	
0801	O	YS-I000B	C/O/H Switch in Computer Position	Raw Water Pumping Station Inlet Valve in Comp Mode	WI-P0002						LCP-H10	DI	
0802	O	ZB-I000A	Closed Status	Raw Water Pumping Station Inlet Valve Closed	WI-P0001						LCP-H10	DI	
0803	O	ZD-I000A	Open Status	Raw Water Pumping Station Inlet Valve Open	WI-P0001						LCP-H10	DI	
0804	O	ZB-I000C	Closed Status	Raw Water Pumping Station Dividing Wall Sluice Gate Closed	WI-P0001						LCP-H10	DI	
0805	O	ZD-I000C	Open Status	Raw Water Pumping Station Dividing Wall Sluice Gate Open	WI-P0001						LCP-H10	DI	
0806	O	ZB-I000B	Closed Status	Raw Water Pumping Station Inlet Valve Closed	WI-P0002						LCP-H10	DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0807	O	ZD-I000B	Open Status	Raw Water Pumping Station Inlet Valve Open	WI-P0002						LCP-H10	DI	
0808	O	MM-I001A	Running Status	Raw Water Pump P-I001A Running	WI-P0003						LCP-H10	DI	
0809	O	MN-I001A	Start Command	Raw Water Pump P-I001A Start	WI-P0003						LCP-H10	DO	
0810	O	SI-I001A	Speed Indicator Indication	Raw Water Pump P-I001A Speed Monitor	WI-P0003						LCP-H10	AI	
0811	O	TI-I001A	Temperature Indication	Raw Water Pump P-I001A Top Bearing Temperature	WI-P0003						LCP-H10	AI TCP	
0812	O	TI-I001B	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0813	O	TI-I001C	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0814	O	TI-I001D	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0815	O	TI-I001E	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0816	O	TI-I001F	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0817	O	TI-I001G	Temperature Indication	Raw Water Pump P-I001A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0818	O	TI-I001H	Temperature Indication	Raw Water Pump P-I001A Bottom Bearing Temperature	WI-P0003						LCP-H10	AI TCP	
0819	O	TI-I001I	Temperature Indication	Raw Water Pump P-I001A VSD Temperature	WI-P0003						LCP-H10	AI TCP	
0820	O	TI-I001J	Temperature Indication	Raw Water Pump P-I001A VSD Temperature	WI-P0003						LCP-H10	AI TCP	
0821	O	UF-I001A	No Fault	Raw Water Pump P-I001A No Fault	WI-P0003						LCP-H10	DI	
0822	O	VI-I001A	Vibration Monitor	Raw Water Pump P-I001A Vibration Monitor	WI-P0003						LCP-H10	AI TCP	
0823	O	YS-I001A	C/O/H Switch in Computer Position	Raw Water Pump P-I001A in Comp Mode	WI-P0003						LCP-H10	DI	
0824	O	YS-I001B	C/O/H Switch in Computer Position	Raw Water Pump P-I001A Speed Control Actuator in Comp Mode	WI-P0003						LCP-H10	DI	
0825	O	ZB-I001C	Closed Status	Raw Water Pump P-I001A Outlet Valve Closed	WI-P0001						LCP-H10	DI	
0826	O	ZD-I001C	Open Status	Raw Water Pump P-I001A Outlet Valve Open	WI-P0001						LCP-H10	DI	
0827	O	ZC-I001B	Position Control Output	Raw Water Pump P-I001A Speed Control Actuator Required Position	WI-P0003						LCP-H10	AO	
0828	O	ZT-I001B	Position Feedback	Raw Water Pump P-I001A Speed Control Actuator Position	WI-P0003						LCP-H10	AI	
0829	O	MM-I002A	Running Status	Raw Water Pump P-I002A Running	WI-P0003						LCP-H10	DI	
0830	O	MN-I002A	Start Command	Raw Water Pump P-I002A Start	WI-P0003						LCP-H10	DO	
0831	O	SI-I002A	Speed Indicator Indication	Raw Water Pump P-I002A Speed Monitor	WI-P0003						LCP-H10	AI	
0832	O	TI-I002A	Temperature Indication	Raw Water Pump P-I002A Top Bearing Temperature	WI-P0003						LCP-H10	AI TCP	
0833	O	TI-I002B	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0834	O	TI-I002C	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0835	O	TI-I002D	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0836	O	TI-I002E	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0837	O	TI-I002F	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0838	O	TI-I002G	Temperature Indication	Raw Water Pump P-I002A Winding Temperature	WI-P0003						LCP-H10	AI TCP	
0839	O	TI-I002H	Temperature Indication	Raw Water Pump P-I002A Bottom Bearing Temperature	WI-P0003						LCP-H10	AI TCP	
0840	O	TI-I002I	Temperature Indication	Raw Water Pump P-I002A VSD Temperature	WI-P0003						LCP-H10	AI TCP	
0841	O	TI-I002J	Temperature Indication	Raw Water Pump P-I002A VSD Temperature	WI-P0003						LCP-H10	AI TCP	
0842	O	UF-I002A	No Fault	Raw Water Pump P-I002A No Fault	WI-P0003						LCP-H10	DI	
0843	O	VI-I002A	Vibration Monitor	Raw Water Pump P-I002A Vibration Monitor	WI-P0003						LCP-H10	AI TCP	
0844	O	YS-I002A	C/O/H Switch in Computer Position	Raw Water Pump P-I002A in Comp Mode	WI-P0003						LCP-H10	DI	
0845	O	YS-I002B	C/O/H Switch in Computer Position	Raw Water Pump P-I002A Speed Control Actuator in Comp Mode	WI-P0003						LCP-H10	DI	
0846	O	ZB-I002C	Closed Status	Raw Water Pump P-I002A Outlet Valve Closed	WI-P0001						LCP-H10	DI	

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PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0847	O	ZD-I002C	Open Status	Raw Water Pump P-I002A Outlet Valve Open	WI-P0001						LCP-H10	DI	
0848	O	ZC-I002B	Position Control Output	Raw Water Pump P-I002A Speed Control Actuator Required Position	WI-P0003						LCP-H10	AO	
0849	O	ZT-I002B	Position Feedback	Raw Water Pump P-I002A Speed Control Actuator Position	WI-P0003						LCP-H10	AI	
0850	O	MM-I003A	Running Status	Raw Water Pump P-I003A Running	WI-P0004						LCP-H10	DI	
0851	O	MN-I003A	Start Command	Raw Water Pump P-I003A Start	WI-P0004						LCP-H10	DO	
0852	O	SI-I003A	Speed Indicator Indication	Raw Water Pump P-I003A Speed Monitor	WI-P0004						LCP-H10	AI	
0853	O	TI-I003A	Temperature Indication	Raw Water Pump P-I003A Top Bearing Temperature	WI-P0004						LCP-H10	AI TCP	
0854	O	TI-I003B	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0855	O	TI-I003C	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0856	O	TI-I003D	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0857	O	TI-I003E	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0858	O	TI-I003F	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0859	O	TI-I003G	Temperature Indication	Raw Water Pump P-I003A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0860	O	TI-I003H	Temperature Indication	Raw Water Pump P-I003A Bottom Bearing Temperature	WI-P0004						LCP-H10	AI	
0861	O	TI-I003I	Temperature Indication	Raw Water Pump P-I003A VSD Temperature	WI-P0004						LCP-H10	AI TCP	
0862	O	TI-I003J	Temperature Indication	Raw Water Pump P-I003A VSD Temperature	WI-P0004						LCP-H10	AI TCP	
0863	O	UF-I003A	No Fault	Raw Water Pump P-I003A No Fault	WI-P0004						LCP-H10	DI	
0864	O	VI-I003A	Vibration Monitor	Raw Water Pump P-I003A Vibration Monitor	WI-P0004						LCP-H10	AI TCP	
0865	O	YS-I003A	C/O/H Switch in Computer Position	Raw Water Pump P-I003A in Comp Mode	WI-P0004						LCP-H10	DI	
0866	O	YS-I003B	C/O/H Switch in Computer Position	Raw Water Pump P-I003A Speed Control Actuator in Comp Mode	WI-P0004						LCP-H10	DI	
0867	O	ZB-I003C	Closed Status	Raw Water Pump P-I003A Outlet Valve Closed	WI-P0002						LCP-H10	DI	
0868	O	ZD-I003C	Open Status	Raw Water Pump P-I003A Outlet Valve Open	WI-P0002						LCP-H10	DI	
0869	O	ZC-I003B	Position Control Output	Raw Water Pump P-I003A Speed Control Actuator Required Position	WI-P0004						LCP-H10	AO	
0870	O	ZT-I003B	Position Feedback	Raw Water Pump P-I003A Speed Control Actuator Position	WI-P0004						LCP-H10	AI	
0871	O	MM-I004A	Running Status	Raw Water Pump P-I004A Running	WI-P0004						LCP-H10	DI	
0872	O	MN-I004A	Start Command	Raw Water Pump P-I004A Start	WI-P0004						LCP-H10	DO	
0873	O	SI-I004A	Speed Indicator Indication	Raw Water Pump P-I004A Speed Monitor	WI-P0004						LCP-H10	AI	
0874	O	TI-I004A	Temperature Indication	Raw Water Pump P-I004A Top Bearing Temperature	WI-P0004						LCP-H10	AI TCP	
0875	O	TI-I004B	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0876	O	TI-I004C	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0877	O	TI-I004D	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0878	O	TI-I004E	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0879	O	TI-I004F	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0880	O	TI-I004G	Temperature Indication	Raw Water Pump P-I004A Winding Temperature	WI-P0004						LCP-H10	AI TCP	
0881	O	TI-I004H	Temperature Indication	Raw Water Pump P-I004A Bottom Bearing Temperature	WI-P0004						LCP-H10	AI TCP	
0882	O	TI-I004I	Temperature Indication	Raw Water Pump P-I004A VSD Temperature	WI-P0004						LCP-H10	AI TCP	
0883	O	TI-I004J	Temperature Indication	Raw Water Pump P-I004A VSD Temperature	WI-P0004						LCP-H10	AI TCP	
0884	O	UF-I004A	No Fault	Raw Water Pump P-I004A No Fault	WI-P0004						LCP-H10	DI	
0885	O	VI-I004A	Vibration Monitor	Raw Water Pump P-I004A Vibration Monitor	WI-P0004						LCP-H10	AI TCP	

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PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0886	O	YS-I004A	C/O/H Switch in Computer Position	Raw Water Pump P-I004A in Comp Mode	WI-P0004						LCP-H10	DI	
0887	O	YS-I004B	C/O/H Switch in Computer Position	Raw Water Pump P-I004A Speed Control Actuator in Comp Mode	WI-P0004						LCP-H10	DI	
0888	O	ZB-I004C	Closed Status	Raw Water Pump P-I004A Outlet Valve Closed	WI-P0002						LCP-H10	DI	
0889	O	ZD-I004C	Open Status	Raw Water Pump P-I004A Outlet Valve Open	WI-P0002						LCP-H10	DI	
0890	O	ZC-I004B	Position Control Output	Raw Water Pump P-I004A Speed Control Actuator Required Position	WI-P0004						LCP-H10	AO	
0891	O	ZT-I004B	Position Feedback	Raw Water Pump P-I004A Speed Control Actuator Position	WI-P0004						LCP-H10	AI	
0892	O	TI-I011A	Temperature Indication	Train 1 Raw Water Temperature	WP-P0001						LCP-H10	AI	
0893	O	TI-I012A	Temperature Indication	Train 2 Raw Water Temperature	WP-P0001						LCP-H10	AI	
0894	O	MM-I013A	Running Status	Train 1 Flash Mixing Pump P-I013A Running	WP-P0001						LCP-H10	DI	
0895	O	MN-I013A	Start Command	Train 1 Flash Mixing Pump P-I013A Start	WP-P0001						LCP-H10	DO	
0896	O	UF-I013A	No Fault	Train 1 Flash Mixing Pump P-I013A Fault	WP-P0001						LCP-H10	DI	
0897	O	YS-I013A	C/O/H Switch in Computer Position	Train 1 Flash Mixing Pump P-I013A in Computer Mode	WP-P0001						LCP-H10	DI	
0898	O	ZB-I013D	Closed Status	Train 1 Flash Mixing Pump P-I013A Discharge Valve Closed	WP-P0001						LCP-H10	DI	
0899	O	ZD-I013D	Open Status	Train 1 Flash Mixing Pump P-I013A Discharge Valve Open	WP-P0001						LCP-H10	DI	
0900	O	MM-I014A	Running Status	Common Standby Flash Mixing Pump P-I014A Running	WP-P0001						LCP-H10	DI	
0901	O	MN-I014A	Start Command	Common Standby Flash Mixing Pump P-I014A Start	WP-P0001						LCP-H10	DO	
0902	O	UF-I014A	No Fault	Common Standby Flash Mixing Pump P-I014A Fault	WP-P0001						LCP-H10	DI	
0903	O	YS-I014A	C/O/H Switch in Computer Position	Common Standby Flash Mixing Pump P-I014A in Computer Mode	WP-P0001						LCP-H10	DI	
0904	O	YB-I014D	Close Command	Common Standby Flash Mixing Pump to Train 1 Valve Close	WP-P0001						LCP-H10	DO	
0905	O	YD-I014D	Open Command	Common Standby Flash Mixing Pump to Train 1 Valve Open	WP-P0001						LCP-H10	DO	
0906	O	YS-I014D	C/O/H Switch in Computer Position	Common Standby Flash Mixing Pump to Train 1 Valve In Computer Mode	WP-P0001						LCP-H10	DI	
0907	O	YB-I014E	Close Command	Common Standby Flash Mixing Pump to Train 2 Valve Close	WP-P0001						LCP-H10	DO	
0908	O	YD-I014E	Open Command	Common Standby Flash Mixing Pump to Train 2 Valve Open	WP-P0001						LCP-H10	DO	
0909	O	YS-I014E	C/O/H Switch in Computer Position	Common Standby Flash Mixing Pump to Train 2 Valve in Computer Mode	WP-P0001						LCP-H10	DI	
0910	O	ZB-I014D	Closed Status	Common Standby Flash Mixing Pump to Train 1 Valve Closed	WP-P0001						LCP-H10	DI	
0911	O	ZD-I014D	Open Status	Common Standby Flash Mixing Pump to Train 1 Valve Open	WP-P0001						LCP-H10	DI	
0912	O	ZB-I014E	Closed Status	Common Standby Flash Mixing Pump to Train 2 Valve Closed	WP-P0001						LCP-H10	DI	
0913	O	ZD-I014E	Open Status	Common Standby Flash Mixing Pump to Train 2 Valve Open	WP-P0001						LCP-H10	DI	
0914	O	MM-I015A	Running Status	Train 2 Flash Mixing Pump P-I015A Running	WP-P0001						LCP-H10	DI	
0915	O	MN-I015A	Start Command	Train 2 Flash Mixing Pump P-I015A Start	WP-P0001						LCP-H10	DO	
0916	O	UF-I015A	No Fault	Train 2 Flash Mixing Pump P-I015A Fault	WP-P0001						LCP-H10	DI	
0917	O	YS-I015A	C/O/H Switch in Computer Position	Train 2 Flash Mixing Pump P-I015A in Computer Mode	WP-P0001						LCP-H10	DI	
0918	O	ZB-I015D	Closed Status	Train 2 Flash Mixing Pump Valve Closed	WP-P0001						LCP-H10	DI	
0919	O	ZD-I015D	Open Status	Train 2 Flash Mixing Pump Discharge Valve Open	WP-P0001						LCP-H10	DI	
0920	O	FA-I017D	Flow Alarm	Train 1 Ferric Chloride Dosing Flow Low	WP-P0001						LCP-H10	DI	
0921	O	FA-I018D	Flow Alarm	Train 2 Ferric Chlroride Dosing Flow Low	WP-P0001						LCP-H10	DI	
0922	O	FA-I022E	Flow Alarm	Train 1 Sulphuric Acid Dosing Flow Low	WP-P0001						LCP-H10	DI	
0923	O	FA-I023E	Flow Alarm	Train 2 Sulfphuric Acid Dosing Flow Low	WP-P0001						LCP-H10	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0924	O	AT-I024B	pH Indication	Raw Water pH	WP-P0001						LCP-H10	AI	
0925	O	FA-I024B	Flow Alarm	Raw Water pH Low Sample Flow	WP-P0001						LCP-H10	DI	
0926	O	AT-I025B	pH Indication	Train 1 Post Flash Mixer Raw Water pH	WP-P0001						LCP-H10	AI	
0927	O	FA-I025B	Flow Alarm	Train 1 Post Flash Mixer Raw Water pH Low Sample Flow	WP-P0001						LCP-H10	DI	
0928	O	AT-I026B	pH Indication	Train 2 Post Flash Mixer Raw Water pH	WP-P0001						LCP-H10	AI	
0929	O	FA-I026B	Flow Alarm	Train 2 Post Flash Mixer Raw Water pH Low Sample Flow	WP-P0001						LCP-H10	DI	
0930	O	AT-I027B	Turbidity Indicator Transmitter	Raw Water Turbidity	WP-P0001						LCP-H10	AI	
0931	O	FA-I027B	Flow Alarm	Raw Water Turbidity Low Sample Flow	WP-P0001						LCP-H10	DI	
0932	O	AI-J001B	Water Hardness Indication	Softened Water Hardness Monitor	WJ-P0001							AI	
0933	O	FI-J001A	Flow Indication	Softened Water Flow to Salt Saturators and Electrolysers Flow Rate	WJ-P0001							AI	
0934	O	FQ-J001A	Flow Pulse	Softened Water Flow to Salt Saturators and Electrolysers Flow Total	WJ-P0001							DI	
0935	O	TI-J003A	Temperature Indication	Softened Water to Electrolysers Temperature	WJ-P0001							AI	
0936	O	LA-J100A	Level Switch	Salt Saturator SS-J100A Brine High Level	WJ-P0001							DI	
0937	O	LF-J100A	Level Fault	Salt Saturator SS-J100A Brine Level Fault	WJ-P0001							DI	
0938	O	LI-J100A	Level Indication	Salt Saturator SS-J100A Brine Level	WJ-P0001							AI	
0939	O	LF-J100B	Level Fault	Salt Saturator SS-J100A Salt Level Fault	WJ-P0001							DI	
0940	O	LI-J100B	Level Indication	Salt Saturator SS-J100A Salt Level	WJ-P0001							AI	
0941	O	TI-J100A	Temperature Indication	Salt Saturator SS-J100A Temperature	WJ-P0001							AI	
0942	O	YD-J100A	Open Command	Softened Water Flow Control Valve to Salt Saturator SS-J100A Valve Open	WJ-P0001							DI	
0943	O	LA-J200A	Level Alarm	Salt Saturator SS-J200A Brine High Level	WJ-P0001							DI	
0944	O	LF-J200A	Level Fault	Salt Saturator SS-J200A Brine Level Fault	WJ-P0001							DI	
0945	O	LI-J200A	Level Indication	Salt Saturator SS-J200A Brine Level	WJ-P0001							AI	
0946	O	LF-J200B	Level Fault	Salt Saturator SS-J200A Salt Level Falt	WJ-P0001							DI	
0947	O	LI-J200B	Level Indication	Salt Saturator SS-J200A Salt Level	WJ-P0001							AI	
0948	O	TI-J200A	Temperature Indication	Salt Saturator SS-J200A Temperature	WJ-P0001							AI	
0949	O	YD-J200A	Open Command	Softened Water Flow Control Valve to Salt Saturator SS-J200A Valve Open	WJ-P0001							DI	
0950	O	MM-J300A	Running Status	Brine to Cell Rack No.1 Pump Running	WJ-P0002							DI	
0951	O	MN-J300A	Start Command	Brine to Cell Rack No.1 Pump Start	WJ-P0002							DI	
0952	O	SC-J300A	Speed Control Output	Brine to Cell Rack No.1 Pump Required Speed	WJ-P0002							AO	
0953	O	SI-J300A	Speed Indication	Brine to Cell Rack No.1 Pump Speed	WJ-P0002							AI	
0954	O	UF-J300A	No Fault	Brine to Cell Rack No.1 Pump Fault	WJ-P0002							DI	
0955	O	YS-J300A	C/O/H Switch in Computer Position	Brine to Cell Rack No.1 Pump in Computer Mode	WJ-P0002							DI	
0956	O	MM-J310A	Running Status	Brine to Cell Rack No.2 Pump Running	WJ-P0002							DI	
0957	O	MN-J310A	Start Command	Brine to Cell Rack No.2 Pump Start	WJ-P0002							DI	
0958	O	SC-J310A	Speed Control Output	Brine to Cell Rack No.2 Pump Required Speed	WJ-P0002							AO	
0959	O	SI-J310A	Speed Indication	Brine to Cell Rack No.2 Pump Speed	WJ-P0002							AI	
0960	O	UF-J310A	No Fault	Brine to Cell Rack No.2 Pump Fault	WJ-P0002							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0961	O	YS-J310A	C/O/H Switch in Computer Position	Brine to Cell Rack No.2 Pump in Computer Mode	WJ-P0002							DI	
0962	O	MM-J320A	Running Status	Brine to Cell Rack No.3 Pump Running	WJ-P0002							DI	
0963	O	MN-J320A	Start Command	Brine to Cell Rack No.3 Pump Start	WJ-P0002							DI	
0964	O	SC-J320A	Speed Control Output	Brine to Cell Rack No.3 Pump Required Speed	WJ-P0002							AO	
0965	O	SI-J320A	Speed Indication	Brine to Cell Rack No.3 Pump Speed	WJ-P0002							AI	
0966	O	UF-J320A	No Fault	Brine to Cell Rack No.3 Pump Fault	WJ-P0002							DI	
0967	O	YS-J320A	C/O/H Switch in Computer Position	Brine to Cell Rack No.3 Pump in Computer Mode	WJ-P0002							DI	
0968	O	MM-J330A	Running Status	Brine to Cell Rack Standby Pump Running	WJ-P0002							DI	
0969	O	MN-J330A	Start Command	Brine to Cell Rack Standby Pump Start	WJ-P0002							DI	
0970	O	SC-J330A	Speed Control Output	Brine to Cell Rack Standby Pump Required Speed	WJ-P0002							AO	
0971	O	SI-J330A	Speed Indication	Brine to Cell Rack Standby Pump Speed	WJ-P0002							AI	
0972	O	UF-J330A	No Fault	Brine to Cell Rack Standby Pump Fault	WJ-P0002							DI	
0973	O	YS-J330A	C/O/H Switch in Computer Position	Brine to Cell Rack Standby Pump in Computer Mode	WJ-P0002							DI	
0974	O	YB-J330K	Close Command	Standby Brine Pump P-J330A to Cell Rack no.3 Valve Close	WJ-P0002							DO	
0975	O	YD-J330K	Open Command	Standby Brine Pump P-J330A to Cell Rack no.3 Valve Open	WJ-P0002							DO	
0976	O	YS-J330K	C/O/H Switch in Computer Position	Standby Brine Pump P-J330A to Cell Rack no.3 Valve in Computer Mode	WJ-P0002							DI	
0977	O	YB-J330L	Close Command	Standby Brine Pump P-J330A to Cell Rack no.2 Valve Close	WJ-P0002							DO	
0978	O	YD-J330L	Open Command	Standby Brine Pump P-J330A to Cell Rack no.2 Valve Open	WJ-P0002							DO	
0979	O	YS-J330L	C/O/H Switch in Computer Position	Standby Brine Pump P-J330A to Cell Rack no.2 Valve in Computer Mode	WJ-P0002							DI	
0980	O	YB-J330M	Close Command	Standby Brine Pump P-J330A to Cell Rack no.1 Valve Close	WJ-P0002							DO	
0981	O	YD-J330M	Open Command	Standby Brine Pump P-J330A to Cell Rack no.1 Valve Open	WJ-P0002							DO	
0982	O	YS-J330M	C/O/H Switch in Computer Position	Standby Brine Pump P-J330A to Cell Rack no.1 Valve in Computer Mode	WJ-P0002							DI	
0983	O	ZB-J330K	Closed Status	Standby Brine Pump P-J330A to Cell Rack no.3 Valve Closed	WJ-P0002							DI	
0984	O	ZD-J330K	Open Status	Standby Brine Pump P-J330A to Cell Rack no.3 Valve Open	WJ-P0002							DI	
0985	O	ZB-J330L	Closed Status	Standby Brine Pump P-J330A to Cell Rack no.2 Valve Closed	WJ-P0002							DI	
0986	O	ZD-J330L	Open Status	Standby Brine Pump P-J330A to Cell Rack no.2 Valve Open	WJ-P0002							DI	
0987	O	ZB-J330M	Closed Status	Standby Brine Pump P-J330A to Cell Rack no.1 Valve Closed	WJ-P0002							DI	
0988	O	ZD-J330M	Open Status	Standby Brine Pump P-J330A to Cell Rack no.1 Valve Open	WJ-P0002							DI	
0989	O	EI-J400A	Voltage Indication	Electrolyser Rectifier Voltage	WJ-P0003							AI	
0990	O	FA-J400A	Flow Alarm	Softened Water Low Flow to Electrolyser EL-J400A	WJ-P0003							DI	
0991	O	FA-J400B	Flow Switch	Softened Water Low Flow to Electrolyser EL-J400A	WJ-P0003							DI	
0992	O	FA-J400C	Flow Switch	Low Brine Flow to Electrolyser EL-J400A	WJ-P0003							DI	
0993	O	FA-J400D	Flow Switch	Low Brine/ Softened Water Flow to Electrolyser EL-J400A	WJ-P0003							DI	
0994	O	FA-J400E	Flow Alarm	Electrolyser EL-J400A Ventilation Low Flow	WJ-P0003							DI	
0995	O	IC-J400A	Current Control	Electrolyser Rectifier Current Control	WJ-P0003							AO	
0996	O	II-J400A	Current Indication	Electrolyser Rectifier Current	WJ-P0003							AI	
0997	O	LA-J400A	Level Switch	Electrolyser EL-J400A High Cell Level	WJ-P0003							DI	
0998	O	LA-J400B	Level Switch	Electrolyser EL-J400A Low Cell Level	WJ-P0003							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
0999	O	LA-J400C	Level Switch	Electrolyser EL-J400A High Cell Level	WJ-P0003							DI	
1000	O	LA-J400D	Level Switch	Electrolyser EL-J400A Low Cell Level	WJ-P0003							DI	
1001	O	MM-J400A	Running Status	Electrolyser EL-J400A Ventilation Blower BLR-J400A Running	WJ-P0003							DI	
1002	O	MN-J400A	Start Command	Electrolyser EL-J400A Ventilation Blower BLR-J400A Start	WJ-P0003							DO	
1003	O	MM-J400B	Running Status	Electrolyser EL-J400A Ventilation Blower BLR-J400B Running	WJ-P0003							DI	
1004	O	MN-J400B	Start Command	Electrolyser EL-J400A Ventilation Blower BLR-J400B Start	WJ-P0003							DO	
1005	O	PA-J400B	Pressure Switch	Electrolyser EL-J400A Cell Pressure High	WJ-P0003							DI	
1006	O	PA-J400C	Pressure Switch	Electrolyser EL-J400A Cell Pressure High	WJ-P0003							DI	
1007	O	PA-J400D	Pressure Switch	Electrolyser EL-J400A Cell Pressure High	WJ-P0003							DI	
1008	O	PA-J400D	Pressure Alarm	Electrolyser EL-J400A Ventilation High Pressure	WJ-P0003							DI	
1009	O	PA-J400E	Pressure Switch	Electrolyser EL-J400A Cell Pressure High	WJ-P0003							DI	
1010	O	TA-J400A	Temperature Alarm	Electrolyser Rectifier RT-J400 High Temperature	WJ-P0003							DI	
1011	O	UF-J400A	No Fault	Electrolyser EL-J400A Ventilation Blower BLR-J400A Fault	WJ-P0003							DI	
1012	O	UF-J400A	No Fault	Electrolyser Rectifier Fault	WJ-P0003							DI	
1013	O	UM-J400A	Running Status	Electrolyser Rectifier Running	WJ-P0003							DI	
1014	O	UR-J400A	No Fault	Electrolyser Rectifier Fan Fault	WJ-P0003							DI	
1015	O	UF-J400B	No Fault	Electrolyser EL-J400A Ventilation Blower BLR-J400B Fault	WJ-P0003							DI	
1016	O	YS-J400A	C/O/H Switch in Computer Position	Electrolyser EL-J400A Ventilation Blower BLR-J400A in Computer Mode	WJ-P0003							DI	
1017	O	YS-J400B	C/O/H Switch in Computer Position	Electrolyser EL-J400A Ventilation Blower BLR-J400B in Computer Mode	WJ-P0003							DI	
1018	O	EI-J420A	Voltage Indication	Electrolyser Rectifier Voltage	WJ-P0003							AI	
1019	O	FA-J420A	Flow Alarm	Softened Water Low Flow to Electrolyser EL-J420A	WJ-P0003							DI	
1020	O	FA-J420B	Flow Alarm	Softened Water Low Flow to Electrolyser EL-J420A	WJ-P0003							DI	
1021	O	FA-J420C	Flow Alarm	Low Brine Flow to Electrolyser EL-J420A	WJ-P0003							DI	
1022	O	FA-J420D	Flow Alarm	Low Brine/ Softened Water Flow to Electrolyser EL-J420A	WJ-P0003							DI	
1023	O	FA-J420E	Flow Alarm	Electrolyser EL-J420A Ventilation Low Flow	WJ-P0003							DI	
1024	O	IC-J420A	Current Control	Electrolyser Rectifier Current Control	WJ-P0003							AO	
1025	O	II-J420A	Current Indication	Electrolyser Rectifier Current	WJ-P0003							AI	
1026	O	LA-J420A	Level Alarm	Electrolyser EL-J420A High Cell Level	WJ-P0003							DI	
1027	O	LA-J420B	Level Alarm	Electrolyser EL-J420A Low Cell Level	WJ-P0003							DI	
1028	O	LA-J420C	Level Alarm	Electrolyser EL-J420A High Cell Level	WJ-P0003							DI	
1029	O	LA-J420D	Level Alarm	Electrolyser EL-J420A Low Cell Level	WJ-P0003							DI	
1030	O	MM-J420A	Running Status	Electrolyser EL-J420A Ventilation Blower BLR-J420A Running	WJ-P0003							DI	
1031	O	MN-J420A	Start Command	Electrolyser EL-J420A Ventilation Blower BLR-J420A Start	WJ-P0003							DO	
1032	O	MM-J420B	Running Status	Electrolyser EL-J420A Ventilation Blower BLR-J420B Running	WJ-P0003							DI	
1033	O	MN-J420B	Start Command	Electrolyser EL-J420A Ventilation Blower BLR-J420B Start	WJ-P0003							DO	
1034	O	PA-J420B	Pressure Alarm	Electrolyser EL-J420A Cell Pressure High	WJ-P0003							DI	
1035	O	PA-J420C	Pressure Alarm	Electrolyser EL-J420A Cell Pressure High	WJ-P0003							DI	
1036	O	PA-J420D	Pressure Alarm	Electrolyser EL-J420A Cell Pressure High	WJ-P0003							DI	
1037	O	PA-J420D	Pressure Alarm	Electrolyser EL-J420A Ventilation High Pressure	WJ-P0003							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1038	O	PA-J420E	Pressure Alarm	Electrolyser EL-J420A Cell Pressure High	WJ-P0003							DI	
1039	O	TA-J420A	Temperature Alarm	Electrolyser Rectifier RT-J420A High Temperature	WJ-P0003							DI	
1040	O	UF-J420A	No Fault	Electrolyser EL-J420A Ventilation Blower BLR-J420A Fault	WJ-P0003							DI	
1041	O	UF-J420A	No Fault	Electrolyser Rectifier Fault	WJ-P0003							DI	
1042	O	UM-J420A	Running Status	Electrolyser Rectifier Running	WJ-P0003							DI	
1043	O	UR-J420A	No Fault	Electrolyser Rectifier Fan Fault	WJ-P0003							DI	
1044	O	UF-J420B	No Fault	Electrolyser EL-J420A Ventilation Blower BLR-J420B Fault	WJ-P0003							DI	
1045	O	YS-J420A	C/O/H Alarm in Computer Position	Electrolyser EL-J420A Ventilation Blower BLR-J420A in Computer Mode	WJ-P0003							DI	
1046	O	YS-J420B	C/O/H Alarm in Computer Position	Electrolyser EL-J420A Ventilation Blower BLR-J420B in Computer Mode	WJ-P0003							DI	
1047	O	EI-J440A	Voltage Indication	Electrolyser Rectifier Voltage	WJ-P0003							AI	
1048	O	FA-J440A	Flow Alarm	Softened Water Low Flow to Electrolyser EL-J440A	WJ-P0003							DI	
1049	O	FA-J440B	Flow Alarm	Softened Water Low Flow to Electrolyser EL-J440A	WJ-P0003							DI	
1050	O	FA-J440C	Flow Alarm	Low Brine Flow to Electrolyser EL-J440A	WJ-P0003							DI	
1051	O	FA-J440D	Flow Alarm	Low Brine/ Softened Water Flow to Electrolyser EL-J440A	WJ-P0003							DI	
1052	O	FA-J440E	Flow Alarm	Electrolyser EL-J440A Ventilation Low Flow	WJ-P0003							DI	
1053	O	IC-J440A	Current Control	Electrolyser Rectifier Current Control	WJ-P0003							AO	
1054	O	II-J440A	Current Indication	Electrolyser Rectifier Current	WJ-P0003							AI	
1055	O	LA-J440A	Level Alarm	Electrolyser EL-J440A High Cell Level	WJ-P0003							DI	
1056	O	LA-J440B	Level Alarm	Electrolyser EL-J440A Low Cell Level	WJ-P0003							DI	
1057	O	LA-J440C	Level Alarm	Electrolyser EL-J440A High Cell Level	WJ-P0003							DI	
1058	O	LA-J440D	Level Alarm	Electrolyser EL-J440A Low Cell Level	WJ-P0003							DI	
1059	O	MM-J440A	Running Status	Electrolyser EL-J440A Ventilation Blower BLR-J440A Running	WJ-P0003							DI	
1060	O	MN-J440A	Start Command	Electrolyser EL-J440A Ventilation Blower BLR-J440A Start	WJ-P0003							DO	
1061	O	MM-J440B	Running Status	Electrolyser EL-J440A Ventilation Blower BLR-J440B Running	WJ-P0003							DI	
1062	O	MN-J440B	Start Command	Electrolyser EL-J440A Ventilation Blower BLR-J440B Start	WJ-P0003							DO	
1063	O	PA-J440B	Pressure Alarm	Electrolyser EL-J440A Cell Pressure High	WJ-P0003							DI	
1064	O	PA-J440C	Pressure Alarm	Electrolyser EL-J440A Cell Pressure High	WJ-P0003							DI	
1065	O	PA-J440D	Pressure Alarm	Electrolyser EL-J440A Cell Pressure High	WJ-P0003							DI	
1066	O	PA-J440D	Pressure Alarm	Electrolyser EL-J440A Ventilation High Pressure	WJ-P0003							DI	
1067	O	PA-J440E	Pressure Alarm	Electrolyser EL-J440A Cell Pressure High	WJ-P0003							DI	
1068	O	TA-J440A	Temperature Alarm	Electrolyser Rectifier RT-J440A High Temperature	WJ-P0003							DI	
1069	O	UF-J440A	No Fault	Electrolyser EL-J440A Ventilation Blower BLR-J440A Fault	WJ-P0003							DI	
1070	O	UF-J440A	No Fault	Electrolyser Rectifier Fault	WJ-P0003							DI	
1071	O	UM-J440A	Running Status	Electrolyser Rectifier Running	WJ-P0003							DI	
1072	O	UR-J440A	No Fault	Electrolyser Rectifier Fan Fault	WJ-P0003							AI	
1073	O	UF-J440B	No Fault	Electrolyser EL-J440A Ventilation Blower BLR-J440B Fault	WJ-P0003							DI	
1074	O	YS-J440A	C/O/H Alarm in Computer Position	Electrolyser EL-J440A Ventilation Blower BLR-J440A in Computer Mode	WJ-P0003							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1075	O	YS-J440B	C/O/H Alarm in Computer Position	Electrolyser EL-J440A Ventilation Blower BLR-J440B in Computer Mode	WJ-P0003							DI	
1076	O	AI-J450A	Hydrogen Gas Indication	Electrolyser Room Hydrogen Gas Level	WJ-P0003							AI	
1077	O	FA-J500A	Flow Alarm	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Flow Low	WJ-P0005							DI	
1078	O	LF-J500A	Level Fault	Sodium Hypochlorite Storage Tank TK-J500A Level Fault	WJ-P0005							DI	
1079	O	LI-J500A	Level Indication	Sodium Hypochlorite Storage Tank TK-J500A Level	WJ-P0005							AI	
1080	O	MM-J500A	Running Status	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Running	WJ-P0005							DI	
1081	O	MN-J500A	Start Command	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Start	WJ-P0005							DO	
1082	O	MM-J500B	Running Status	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Running	WJ-P0005							DI	
1083	O	MN-J500B	Start Command	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Start	WJ-P0005							DO	
1084	O	PA-J500A	Pressure Alarm	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Pressure High	WJ-P0005							DI	
1085	O	UF-J500A	No Fault	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Fault	WJ-P0005							DI	
1086	O	UF-J500B	No Fault	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower Fault	WJ-P0005							DI	
1087	O	YS-J500A	C/O/H Alarm in Computer Position	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower in Computer Mode	WJ-P0005							DI	
1088	O	YS-J500B	C/O/H Alarm in Computer Position	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Blower in Computer Mode	WJ-P0005							DI	
1089	O	FA-J520A	Flow Alarm	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Flow Low	WJ-P0005							DI	
1090	O	LF-J520A	Level Fault	Sodium Hypochlorite Storage Tank TK-J520A Level Fault	WJ-P0005							DI	
1091	O	LI-J520A	Level Indication	Sodium Hypochlorite Storage Tank TK-J520A Level	WJ-P0005							AI	
1092	O	MM-J520A	Running Status	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Running	WJ-P0005							DI	
1093	O	MN-J520A	Start Command	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Start	WJ-P0005							DO	
1094	O	MM-J520B	Running Status	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Running	WJ-P0005							DI	
1095	O	MN-J520B	Start Command	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Start	WJ-P0005							DO	
1096	O	PA-J520A	Pressure Alarm	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Pressure High	WJ-P0005							DI	
1097	O	UF-J520A	No Fault	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Fault	WJ-P0005							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1098	O	UF-J520B	No Fault	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower Fault	WJ-P0005							DI	
1099	O	YS-J520A	C/O/H Alarm in Computer Position	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower in Computer Mode	WJ-P0005							DI	
1100	O	YS-J520B	C/O/H Alarm in Computer Position	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Blower in Computer Mode	WJ-P0005							DI	
1101	O	AI-J550A	Gas Indication	Sodium Hypochlorite Storage Room Hydrogen Gas Level	WJ-P0005							AI	
1102	O	LA-J550A	Level Alarm	Sodium Hypochlorite Containmnent Sump High	WJ-P0005							DI	
1103	O	FI-J600A	Flow Indication	Sodium Hypochlorite to Chlorine Contact Tank Influent Flow Rate	WJ-P0006							AI	
1104	O	FQ-J600A	Flow Pulse	Sodium Hypochlorite to Chlorine Contact Tank Influent Flow Total	WJ-P0006							DI	
1105	O	MM-J610A	Running Status	Sodium Hypochlorite to Chlorine Contact Tank Pump Running	WJ-P0006							DI	
1106	O	MN-J610A	Start Command	Sodium Hypochlorite to Chlorine Contact Tank Pump Start	WJ-P0006							DO	
1107	O	SC-J610A	Speed Control Output	Sodium Hypochlorite to Chlorine Contact Tank Pump Required Speed	WJ-P0006							AO	
1108	O	SI-J610A	Speed Indication	Sodium Hypochlorite to Chlorine Contact Tank Pump Speed	WJ-P0006							AI	
1109	O	UF-J610A	No Fault	Sodium Hypochlorite to Chlorine Contact Tank Pump Fault	WJ-P0006							DI	
1110	O	YB-J610A	Close Command	Sodium Hypochlorite Pump P-J610A Outlet Control Valve Close	WJ-P0006							DO	
1111	O	YD-J610A	Open Command	Sodium Hypochlorite Pump P-J610A Outlet Control Valve Open	WJ-P0006							DO	
1112	O	YS-J610A	C/O/H Switch in Computer Position	Sodium Hypochlorite to Chlorine Contact Tank Pump in Computer Mode	WJ-P0006							DI	
1113	O	YS-J610A	C/O/H Switch in Computer Position	Sodium Hypochlorite Pump P-J610A Outlet Control Valve in Computer Mode	WJ-P0006							DI	
1114	O	ZB-J610A	Closed Status	Sodium Hypochlorite Pump P-J610A Outlet Control Valve Closed	WJ-P0006							DI	
1115	O	ZD-J610A	Open Status	Sodium Hypochlorite Pump P-J610A Outlet Control Valve Open	WJ-P0006							DI	
1116	O	ZS-J610A	Revolution Sensor	Sodium Hypochlorite to Chlorine Contact Tank Pump Revolution	WJ-P0006							DI	
1117	O	MM-J620A	Running Status	Sodium Hypochlorite to Chlorine Contact Tank Pump Running	WJ-P0006							DI	
1118	O	MN-J620A	Start Command	Sodium Hypochlorite to Chlorine Contact Tank Pump Start	WJ-P0006							DO	
1119	O	SC-J620A	Speed Control Output	Sodium Hypochlorite to Chlorine Contact Tank Pump Required Speed	WJ-P0006							AO	
1120	O	SI-J620A	Speed Indication	Sodium Hypochlorite to Chlorine Contact Tank Pump Speed	WJ-P0006							AI	
1121	O	UF-J620A	No Fault	Sodium Hypochlorite to Chlorine Contact Tank Pump Fault	WJ-P0006							DI	
1122	O	YB-J620A	Close Command	Sodium Hypochlorite Pump P-J620A Outlet Control Valve Close	WJ-P0006							DO	
1123	O	YD-J620A	Open Command	Sodium Hypochlorite Pump P-J620A Outlet Control Valve Open	WJ-P0006							DO	
1124	O	YS-J620A	C/O/H Switch in Computer Position	Sodium Hypochlorite to Chlorine Contact Tank Pump in Computer Mode	WJ-P0006							DI	
1125	O	YS-J620A	C/O/H Switch in Computer Position	Sodium Hypochlorite Pump P-J620A Outlet Control Valve in Computer Mode	WJ-P0006							DI	
1126	O	ZB-J620A	Closed Status	Sodium Hypochlorite Pump P-J620A Outlet Control Valve Closed	WJ-P0006							DI	
1127	O	ZD-J620A	Open Status	Sodium Hypochlorite Pump P-J620A Outlet Control Valve Open	WJ-P0006							DI	
1128	O	ZS-J620A	Revolution Sensor	Sodium Hypochlorite to Chlorine Contact Tank Pump Revolution Sensor	WJ-P0006							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1129	O	FI-J640A	Flow Indication	Sodium Hypochlorite to Filtered Water Channel Flow Rate	WJ-P0006							AI	
1130	O	FQ-J640A	Flow Pulse	Sodium Hypochlorite to Filtered Water Channel Flow Total	WJ-P0006							DI	
1131	O	MM-J640A	Running Status	Sodium Hypochlorite to Filtered Water Channel Pump Running	WJ-P0006							DI	
1132	O	MN-J640A	Start Command	Sodium Hypochlorite to Filtered Water Channel Pump Start	WJ-P0006							DO	
1133	O	SC-J640A	Speed Control Output	Sodium Hypochlorite to Filtered Water Channel Pump Required Speed	WJ-P0006							AO	
1134	O	SI-J640A	Speed Indication	Sodium Hypochlorite to Filtered Water Channel Pump Speed	WJ-P0006							AI	
1135	O	UF-J640A	No Fault	Sodium Hypochlorite to Filtered Water Channel Pump Fault	WJ-P0006							DI	
1136	O	YB-J640A	Close Command	Sodium Hypochlorite Pump P-J640A Outlet Control Valve Close	WJ-P0006							DO	
1137	O	YD-J640A	Open Command	Sodium Hypochlorite Pump P-J640A Outlet Control Valve Open	WJ-P0006							DO	
1138	O	YS-J640A	C/O/H Switch in Computer Position	Sodium Hypochlorite to Filtered Water Channel Pump in Computer Mode	WJ-P0006							DI	
1139	O	YS-J640A	C/O/H Switch in Computer Position	Sodium Hypochlorite Pump P-J640A Outlet Control Valve in Computer Mode	WJ-P0006							DI	
1140	O	ZB-J640A	Closed Status	Sodium Hypochlorite Pump P-J640A Outlet Control Valve Clsed	WJ-P0006							DI	
1141	O	ZD-J640A	Open Status	Sodium Hypochlorite Pump P-J640A Outlet Control Valve Open	WJ-P0006							DI	
1142	O	ZS-J640A	Revolution Sensor	Sodium Hypochlorite to Filtered Water Channel Pump Pump Revolution	WJ-P0006							DI	
1143	O	MM-J660A	Running Status	Sodium Hypochlorite to Filtered Water Channel Pump Running	WJ-P0006							DI	
1144	O	MN-J660A	Start Command	Sodium Hypochlorite to Filtered Water Channel Pump Start	WJ-P0006							DO	
1145	O	SC-J660A	Speed Control Output	Sodium Hypochlorite to Filtered Water Channel Pump Required Speed	WJ-P0006							AO	
1146	O	SI-J660A	Speed Indication	Sodium Hypochlorite to Filtered Water Channel Pump Speed	WJ-P0006							AI	
1147	O	UF-J660A	No Fault	Sodium Hypochlorite to Filtered Water Channel Pump Fault	WJ-P0006							DI	
1148	O	YB-J660A	Close Command	Sodium Hypochlorite Pump P-J660A Outlet Control Valve Closed	WJ-P0006							DO	
1149	O	YD-J660A	Open Command	Sodium Hypochlorite Pump P-J660A Outlet Control Valve Open	WJ-P0006							DO	
1150	O	YS-J660A	C/O/H Switch in Computer Position	Sodium Hypochlorite to Filtered Water Channel Pump in Computer Mode	WJ-P0006							DI	
1151	O	YS-J660A	C/O/H Switch in Computer Position	Sodium Hypochlorite Pump P-J660A Outlet Control Valve in Computer Mode	WJ-P0006							DI	
1152	O	ZB-J660A	Closed Status	Sodium Hypochlorite Pump P-J660A Outlet Control Valve Closed	WJ-P0006							DI	
1153	O	ZD-J660A	Open Status	Sodium Hypochlorite Pump P-J660A Outlet Control Valve Open	WJ-P0006							DI	
1154	O	ZS-J660A	Revolution Sensor	Sodium Hypochlorite to Filtered Water Channel Pump Pump Revolution	WJ-P0006							DI	
1155	O	YB-J665A	Close Command	Sodium Hypochlorite to Backwash Supply Flow Control Valve Close	WJ-P0006							DO	
1156	O	YD-J665A	Open Command	Sodium Hypochlorite to Backwash Supply Flow Control Valve Open	WJ-P0006							DO	
1157	O	YS-J665A	C/O/H Switch in Computer Position	Sodium Hypochlorite to Backwash Supply Flow Control Valve in Computer Mode	WJ-P0006							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1158	O	ZB-J665A	Closed Status	Sodium Hypochlorite to Backwash Supply Flow Control Valve Closed	WJ-P0006							DI	
1159	O	ZD-J665A	Open Status	Sodium Hypochlorite to Backwash Supply Flow Control Valve Open	WJ-P0006							DI	
1160		FI-J701A	Discharge Flow	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1161		FQ-J701A	Discharge Flow Pulse	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1162		MM-J701A	Running Status	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1163		MN-J701A	Start Command	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DO	
1164		PS-J701A	Discharge Pressure High	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1165		UF-J701A	No Fault	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1166		YS-J701A	C/O/H Switch in Computer Position	HypoChlorite Mixing Pump P-J701A	WF-P0011						LCP-R21	DI	
1167		YB-J701C	Close Command	HypoChlorite Mixing Pump P-J701A Discharge Valve	WF-P0011						LCP-R21	DI	
1168		YD-J701C	Open Command	HypoChlorite Mixing Pump P-J701A Discharge Valve	WF-P0011						LCP-R21	DI	
1169		YS-J701C	C/O/H Switch in Computer Position	HypoChlorite Mixing Pump P-J701A Discharge Valve	WF-P0011						LCP-R21	DI	
1170		ZB-J701C	Closed Status	HypoChlorite Mixing Pump P-J701A Discharge Valve	WF-P0011						LCP-R21	DI	
1171		ZD-J701C	Open Status	HypoChlorite Mixing Pump P-J701A Discharge Valve	WF-P0011						LCP-R21	DI	
1172		FI-J702A	Discharge Flow	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1173		FQ-J702A	Discharge Flow Pulse	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1174		MM-J702A	Running Status	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1175		MN-J702A	Start Command	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DO	
1176		PS-J702A	Discharge Pressure High	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1177		UF-J702A	No Fault	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1178		YS-J702A	C/O/H Switch in Computer Position	HypoChlorite Mixing Pump P-J702A	WF-P0011						LCP-R21	DI	
1179		YB-J702C	Close Command	HypoChlorite Mixing Pump P-J702A Discharge Valve	WF-P0011						LCP-R21	DI	
1180		YD-J702C	Open Command	HypoChlorite Mixing Pump P-J702A Discharge Valve	WF-P0011						LCP-R21	DI	
1181		YS-J702C	C/O/H Switch in Computer Position	HypoChlorite Mixing Pump P-J702A Discharge Valve	WF-P0011						LCP-R21	DI	
1182		ZB-J702C	Closed Status	HypoChlorite Mixing Pump P-J702A Discharge Valve	WF-P0011						LCP-R21	DI	
1183		ZD-J702C	Open Status	HypoChlorite Mixing Pump P-J702A Discharge Valve	WF-P0011						LCP-R21	DI	
1184		YB-J703C	Close Command	HypoChlorite Mixing Pump P-J703A Crossover Valve	WF-P0011						LCP-R21	DI	
1185		YD-J703C	Open Command	HypoChlorite Mixing Pump P-J703A Crossover Valve	WF-P0011						LCP-R21	DI	
1186		YS-J703C	C/O/H Switch in Computer Position	HypoChlorite Mixing Pump P-J703A Crossover Valve	WF-P0011						LCP-R21	DI	
1187		ZB-J703C	Closed Status	HypoChlorite Mixing Pump P-J703A Crossover Valve	WF-P0011						LCP-R21	DI	
1188		ZD-J703C	Open Status	HypoChlorite Mixing Pump P-J703A Crossover Valve	WF-P0011						LCP-R21	DI	
1189	O	YD-J991A	Open Command	Sodium Hypochlorite to Backwash Pump P-F911A Valve Open	WF-P0009						LCP-F01	DO	
1190	O	YD-J992A	Open Command	Sodium Hypochlorite to Backwash Pump P-F921A Valve Open	WF-P0009						LCP-F02	DO	
1191	O	LS-O010A	Level Alarm	Liquid Oxygen Storage Tank #1 Level High	WO-P0001						CP-O11	DI	
1192	O	LF-O010A	Level Fault	Liquid Oxygen Storage Tank #1 Level Fault	WO-P0001						CP-O11	DI	
1193	O	LT-O010A	Level Indication	Liquid Oxygen Storage Tank #1 Level	WO-P0001						CP-O11	AI	
1194	O	PS-O010A	Pressure Alarm	Liquid Oxygen Storage Tank #1 Pressure High	WO-P0001						CP-O11	DI	
1195	O	PT-O010A	Pressure Indicator Transmitter	Liquid Oxygen Storage Tank #1 Pressure	WO-P0001						CP-O11	AI	
1196	O	YB-O010A	Close Command	Liquid Oxygen Storage Tank #1 Outlet Valve Close	WO-P0001						CP-O11	DO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1197	O	YD-O010A	Open Command	Liquid Oxygen Storage Tank #1 Outlet Valve Open	WO-P0001						CP-O11	DO	
1198	O	YS-O010A	C/O/H Switch in Computer Position	Liquid Oxygen Storage Tank #1 Outlet Valve in Computer Mode	WO-P0001						CP-O11	DI	
1199	O	ZB-O010A	Closed Status	Liquid Oxygen Storage Tank #1 Outlet Valve Closed	WO-P0001						CP-O11	DI	
1200	O	ZD-O010A	Open Status	Liquid Oxygen Storage Tank #1 Outlet Valve Open	WO-P0001						CP-O11	DI	
1201	O	YB-O011A	Close Command	Liquid Storage Tank #1 Automatic Switchover Valve Close	WO-P0001						CP-O11	DO	
1202	O	YD-O011A	Open Command	Liquid Storage Tank #1 Automatic Switchover Valve Open	WO-P0001						CP-O11	DO	
1203	O	YS-O011A	C/O/H Switch in Computer Position	Liquid Storage Tank #1 Automatic Switchover Valve in Computer Mode	WO-P0001						CP-O11	DI	
1204	O	ZB-O011A	Closed Status	Liquid Storage Tank #1 Automatic Switchover Valve Closed	WO-P0001						CP-O11	DI	
1205	O	ZD-O011A	Open Status	Liquid Storage Tank #1 Automatic Switchover Valve Open	WO-P0001						CP-O11	DI	
1206	O	TT-O012A	Temperature Indication	Liquid Oxygen Temperature	WO-P0001						CP-O11	AI	
1207	O	PT-O015A	Pressure Indication	Liquid Oxygen Storage Tank Outlet Pressure	WO-P0001						CP-O11	AI	
1208	O	YB-O015A	Close Command	Liquid Oxygen Master Oxygen Shutoff Valve Close	WO-P0001						CP-O11	DO	
1209	O	YD-O015A	Open Command	Liquid Oxygen Master Oxygen Shutoff Valve Open	WO-P0001						CP-O11	DO	
1210	O	YS-O015A	C/O/H Switch in Computer Position	Liquid Oxygen Master Oxygen Shutoff Valve in Computer Mode	WO-P0001						CP-O11	DI	
1211	O	ZB-O015A	Closed Status	Liquid Oxygen Master Oxygen Shutoff Valve Closed	WO-P0001						CP-O11	DI	
1212	O	ZD-O015A	Open Status	Liquid Oxygen Master Oxygen Shutoff Valve Open	WO-P0001						CP-O11	DI	
1213	O	LS-O020A	Level Switch	Liquid Oxygen Storage Tank #2 Level High	WO-P0002						CP-O11	DI	
1214	O	LF-O020A	Level Fault	Liquid Oxygen Storage Tank #2 Level	WO-P0002						CP-O11	DI	
1215	O	LI-O020A	Level Indication	Liquid Oxygen Storage Tank #2 Level	WO-P0002						CP-O11	AI	
1216	O	PS-O020A	Pressure Switch	Liquid Oxygen Storage Tank #2 Pressure High	WO-P0002						CP-O11	DI	
1217	O	PI-O020A	Pressure Indication	Liquid Oxygen Storage Tank #2 Pressure	WO-P0002						CP-O11	AI	
1218	O	YB-O020A	Close Command	Liquid Oxygen Storage Tank #2 Outlet Valve Close	WO-P0002						CP-O11	DO	
1219	O	YD-O020A	Open Command	Liquid Oxygen Storage Tank #2 Outlet Valve Open	WO-P0002						CP-O11	DO	
1220	O	YS-O020A	C/O/H Switch in Computer Position	Liquid Oxygen Storage Tank #2 Outlet Valve in Computer Mode	WO-P0002						CP-O11	DI	
1221	O	ZB-O020A	Closed Status	Liquid Oxygen Storage Tank #2 Outlet Valve Closed	WO-P0002						CP-O11	DI	
1222	O	ZD-O020A	Open Status	Liquid Oxygen Storage Tank #2 Outlet Valve Open	WO-P0002						CP-O11	DI	
1223	O	YB-O021A	Close Command	Liquid Storage Tank #2 Automatic Switchover Valve Close	WO-P0001						CP-O11	DO	
1224	O	YD-O021A	Open Command	Liquid Storage Tank #2 Automatic Switchover Valve Open	WO-P0001						CP-O11	DO	
1225	O	YS-O021A	C/O/H Switch in Computer Position	Liquid Storage Tank #2 Automatic Switchover Valve in Computer Mode	WO-P0001						CP-O11	DI	
1226	O	ZB-O021A	Closed Status	Liquid Storage Tank #2 Automatic Switchover Valve Closed	WO-P0001						CP-O11	DI	
1227	O	ZD-O021A	Open Status	Liquid Storage Tank #2 Automatic Switchover Valve Open	WO-P0001						CP-O11	DI	
1228	O	PI-O030A	Pressure Indication	Liquid Oxygen Particle Filter GFO030 Differential Pressure	WO-P0003						CP-O30	AI	
1229	O	AI-O032A	Dewpoint Indication	Liquid Oxygen to Ozone Generators Dewpoint Analyzer	WO-P0003						CP-O30	AI	
1230	O	PA-O050A	Pressure Switch	Nitrogen Boost Air Receiver Pressure Switch High	WO-P0004						CP-O30	DI	
1231	O	AI-O051A	Dew Point Indication	Nitrogen Boost Unit to Ozone Generator Dewpoint	WO-P0004						CP-O30	AI	
1232	O	FS-O051A	Flow Switch	Nitrogen Boost Unit to Ozone Generators Low Flow	WO-P0004						CP-O30	DI	
1233	O	YD-O051A	Open Command	Nitrogen Boost Unit to Ozone Generators Flow Control Valve Open	WO-P0004						CP-O30	DO	
1234	O	MM-O052A	Running Status	Nitrogen Boost Unit Compressor CMP-O052A Running	WO-P0004						CP-O30	DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1235	O	MN-O052A	Start Command	Nitrogen Boost Unit Compressor CMP-O052A Start	WO-P0004						CP-O30	DO	
1236	O	UF-O052A	No Fault	Nitrogen Boost Unit Compressor CMP-O052A Fault	WO-P0004						CP-O30	DI	
1237	O	YS-O052A	C/O/H Switch in Computer Position	Nitrogen Boost Unit Compressor CMP-O052A in Computer Mode	WO-P0004						CP-O30	DI	
1238	O	MM-O053A	Running Status	Nitrogen Boost Unit Compressor CMP-O053A Running	WO-P0004						CP-O30	DI	
1239	O	MN-O053A	Start Command	Nitrogen Boost Unit Compressor CMP-O053A Start	WO-P0004						CP-O30	DO	
1240	O	UF-O053A	No Fault	Nitrogen Boost Unit Compressor CMP-O053A Fault	WO-P0004						CP-O30	DI	
1241	O	YS-O053A	C/O/H Switch in Computer Position	Nitrogen Boost Unit Compressor CMP-O053A in Computer Mode	WO-P0004						CP-O30	DI	
1242	O	AI-O110A	Gas Level Indication	Ambient Ozone Gas Level	WO-P0005						CP-O30	AI	
1243	O	AI-O110B	Gas Level Indication	Ambient Oxygen Gas Level	WO-P0005						CP-O30	AI	
1244	O	PI-O110A	Pressure Indication	Liquid Oxygen to Ozone Generator GEN-O110A Pressure	WO-P0005						CP-O31	AI	
1245	O	TI-O110A	Temperature Indication	Liquid Oxygen to Ozone Generator GEN-O110A Temperature	WO-P0005						CP-O31	AI	
1246	O	FI-O111A	Flow Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Flow Rate	WO-P0016							AI	
1247	O	FQ-O111A	Flow Pulse	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Flow Total	WO-P0016							AI	
1248	O	PI-O111A	Pressure Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Pressure	WO-P0016							AI	
1249	O	YB-O111A	Close Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Valve Close	WO-P0016							DO	
1250	O	YD-O111A	Open Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Valve Open	WO-P0016							DO	
1251	O	YS-O111A	C/O/H Switch in Computer Position	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Valve in Computer Mode	WO-P0016							DI	
1252	O	ZB-O111A	Closed Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Valve Closed	WO-P0016							DI	
1253	O	ZD-O111A	Open Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Valve Open	WO-P0016							DI	
1254	O	AI-O112A	Ozone Gas Concentration Indication	Ozone Generator GEN-O110A Outlet Ozone Gas Concentration	WO-P0005							AI	
1255	O	FI-O112A	Flow Indication	Ozone Generator GEN-O110A Flow Rate	WO-P0005							AI	
1256	O	FQ-O112A	Flow Pulse	Ozone Generator GEN-O110A Flow Total	WO-P0005							DI	
1257	O	PI-O112A	Pressure Indication	Ozone Generator GEN-O110A Outlet Pressure	WO-P0005							AI	
1258	O	TI-O112A	Temperature Indication	Ozone Generator GEN-O110A Outlet Temperature	WO-P0005							AI	
1259	O	YB-O112A	Close Command	Ozone Generator GEN-O110A Outlet Control Valve Close	WO-P0005							DO	
1260	O	YD-O112A	Open Command	Ozone Generator GEN-O110A Outlet Control Valve Open	WO-P0005							DI	
1261	O	YS-O112A	C/O/H Switch in Computer Position	Ozone Generator GEN-O110A Outlet Flow Control Valve in Computer Mode	WO-P0005							DI	
1262	O	YS-O112A	C/O/H Switch in Computer Position	Ozone Generator GEN-O110A Outlet Control Valve in Computer Mode	WO-P0005							DI	
1263	O	ZB-O112A	Closed Status	Ozone Generator GEN-O110A Outlet Flow Control Valve Closed	WO-P0005							DI	
1264	O	ZB-O112A	Closed Status	Ozone Generator GEN-O110A Outlet Control Valve Closed	WO-P0005							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1265	O	ZC-O112A	Position Control Output	Ozone Generator GEN-O110A Outlet Flow Control Valve Required Position	WO-P0005							AO	
1266	O	ZD-O112A	Open Status	Ozone Generator GEN-O110A Outlet Flow Control Valve Open	WO-P0005							DI	
1267	O	ZD-O112A	Open Status	Ozone Generator GEN-O110A Outlet Control Valve Open	WO-P0005							DI	
1268	O	ZT-O112A	Position Feedback	Ozone Generator GEN-O110A Outlet Flow Control Valve Position	WO-P0005							AI	
1269	O	YB-O119A	Close Command	Liquid Oxygen to Ozone Generator GEN-O110A Flow Control Valve Close	WO-P0005							DO	
1270	O	YD-O119A	Open Command	Liquid Oxygen to Ozone Generator GEN-O110A Flow Control Valve Open	WO-P0005							DO	
1271	O	YS-O119A	C/O/H Switch in Computer Position	Liquid Oxygen to Ozone Generator GEN-O110A Flow Control Valve in Computer Mode	WO-P0005							DI	
1272	O	ZB-O119A	Closed Status	Liquid Oxygen to Ozone Generator GEN-O110A Flow Control Valve Closed	WO-P0005							DI	
1273	O	ZD-O119A	Open Status	Liquid Oxygen to Ozone Generator GEN-O110A Flow Control Valve Open	WO-P0005							DI	
1274	O	AI-O130A	Gas Level Indication	Ambient Ozone Gas Level	WO-P0006							AI	
1275	O	AI-O130B	Gas Level Indication	Ambient Oxygen Gas Level	WO-P0006							AI	
1276	O	PI-O130A	Pressure Indication	Liquid Oxygen to Ozone Generator GEN-O130A Pressure	WO-P0006							AI	
1277	O	TI-O130A	Temperature Indication	Liquid Oxygen to Ozone Generator GEN-O130A Temperature	WO-P0006							AI	
1278	O	FI-O131A	Flow Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Flow Rate	WO-P0017							AI	
1279	O	FQ-O131A	Flow Pulse	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Flow Total	WO-P0017							AI	
1280	O	PI-O131A	Pressure Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Pressure	WO-P0017							AI	
1281	O	YB-O131A	Close Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Valve Close	WO-P0017							DO	
1282	O	YD-O131A	Open Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Valve Open	WO-P0017							DO	
1283	O	YS-O131A	C/O/H Switch in Computer Position	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Valve in Computer Mode	WO-P0017							DI	
1284	O	ZB-O131A	Closed Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Valve Closed	WO-P0017							DI	
1285	O	ZD-O131A	Open Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Valve Open	WO-P0017							DI	
1286	O	AI-O132A	Ozone Gas Concentration Indication	Ozone Generator GEN-O130A Outlet Ozone Gas Concentration	WO-P0006							AI	
1287	O	FI-O132A	Flow Indication	Ozone Generator GEN-O130A Flow Rate	WO-P0006							AI	
1288	O	FQ-O132A	Flow Pulse	Ozone Generator GEN-O130A Flow Total	WO-P0006							DI	
1289	O	PI-O132A	Pressure Indication	Ozone Generator GEN-O130A Outlet Pressure	WO-P0006							AI	
1290	O	TI-O132A	Temperature Indication	Ozone Generator GEN-O130A Outlet Temperature	WO-P0006							AI	
1291	O	YB-O132A	Close Command	Ozone Generator GEN-O130A Outlet Control Valve Close	WO-P0006							DO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1292	O	YD-O132A	Open Command	Ozone Generator GEN-O130A Outlet Control Valve Open	WO-P0006							DI	
1293	O	YS-O132A	C/O/H Switch in Computer Position	Ozone Generator GEN-O130A Outlet Flow Control Valve in Computer Mode	WO-P0006							DI	
1294	O	YS-O132A	C/O/H Switch in Computer Position	Ozone Generator GEN-O130A Outlet Control Valve in Computer Mode	WO-P0006							DI	
1295	O	ZB-O132A	Closed Status	Ozone Generator GEN-O130A Outlet Flow Control Valve Closed	WO-P0006							DI	
1296	O	ZB-O132A	Closed Status	Ozone Generator GEN-O130A Outlet Control Valve Closed	WO-P0006							DI	
1297	O	ZC-O132A	Position Control Output	Ozone Generator GEN-O130A Outlet Flow Control Valve Required Position	WO-P0006							AO	
1298	O	ZD-O132A	Open Status	Ozone Generator GEN-O130A Outlet Flow Control Valve Open	WO-P0006							DI	
1299	O	ZD-O132A	Open Status	Ozone Generator GEN-O130A Outlet Control Valve Open	WO-P0006							DI	
1300	O	ZT-O132A	Position Feedback	Ozone Generator GEN-O130A Outlet Flow Control Valve Position	WO-P0006							AI	
1301	O	YB-O139A	Close Command	Liquid Oxygen to Ozone Generator GEN-O130A Flow Control Valve Close	WO-P0006							DO	
1302	O	YD-O139A	Open Command	Liquid Oxygen to Ozone Generator GEN-O130A Flow Control Valve Open	WO-P0006							DO	
1303	O	YS-O139A	C/O/H Switch in Computer Position	Liquid Oxygen to Ozone Generator GEN-O130A Flow Control Valve in Computer Mode	WO-P0006							DI	
1304	O	ZB-O139A	Closed Status	Liquid Oxygen to Ozone Generator GEN-O130A Flow Control Valve Closed	WO-P0006							DI	
1305	O	ZD-O139A	Open Status	Liquid Oxygen to Ozone Generator GEN-O130A Flow Control Valve Open	WO-P0006							DI	
1306	O	AI-O150A	Gas Level Indication	Ambient Ozone Gas Level	WO-P0007							AI	
1307	O	PI-O150A	Pressure Indication	Liquid Oxygen to Ozone Generator GEN-O150A Pressure	WO-P0007							AI	
1308	O	TI-O150A	Temperature Indication	Liquid Oxygen to Ozone Generator GEN-O150A Temperature	WO-P0007							AI	
1309	O	FI-O151A	Flow Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Flow Rate	WO-P0018							AI	
1310	O	FQ-O151A	Flow Pulse	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Flow Total	WO-P0018							AI	
1311	O	PI-O151A	Pressure Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Pressure	WO-P0018							AI	
1312	O	YB-O151A	Close Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Valve Close	WO-P0018							DO	
1313	O	YD-O151A	Open Command	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Valve Open	WO-P0018							DO	
1314	O	YS-O151A	C/O/H Switch in Computer Position	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Valve in Computer Mode	WO-P0018							DI	
1315	O	ZB-O151A	Closed Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Valve Closed	WO-P0018							DI	
1316	O	ZD-O151A	Open Status	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Valve Open	WO-P0018							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1317	O	AI-O152A	Ozone Gas Concentration Indication	Ozone Generator GEN-O150A Outlet Ozone Gas Concentration	WO-P0007							AI	
1318	O	FI-O152A	Flow Indication	Ozone Generator GEN-O150A Flow Rate	WO-P0007							AI	
1319	O	FQ-O152A	Flow Pulse	Ozone Generator GEN-O150A Flow Total	WO-P0007							DI	
1320	O	PI-O152A	Pressure Indication	Ozone Generator GEN-O150A Outlet Pressure	WO-P0007							AI	
1321	O	TI-O152A	Temperature Indication	Ozone Generator GEN-O150A Outlet Temperature	WO-P0007							AI	
1322	O	YB-O152A	Close Command	Ozone Generator GEN-O150A Outlet Control Valve Close	WO-P0007							DO	
1323	O	YD-O152A	Open Command	Ozone Generator GEN-O150A Outlet Control Valve Open	WO-P0007							DI	
1324	O	YS-O152A	C/O/H Switch in Computer Position	Ozone Generator GEN-O150A Outlet Flow Control Valve in Computer Mode	WO-P0007							DI	
1325	O	YS-O152A	C/O/H Switch in Computer Position	Ozone Generator GEN-O150A Outlet Control Valve in Computer Mode	WO-P0007							DI	
1326	O	ZB-O152A	Closed Status	Ozone Generator GEN-O150A Outlet Flow Control Valve Closed	WO-P0007							DI	
1327	O	ZB-O152A	Closed Status	Ozone Generator GEN-O150A Outlet Control Valve Closed	WO-P0007							DI	
1328	O	ZC-O152A	Position Control Output	Ozone Generator GEN-O150A Outlet Flow Control Valve Required Position	WO-P0007							AO	
1329	O	ZD-O152A	Open Status	Ozone Generator GEN-O150A Outlet Flow Control Valve Open	WO-P0007							DI	
1330	O	ZD-O152A	Open Status	Ozone Generator GEN-O150A Outlet Control Valve Open	WO-P0007							DI	
1331	O	ZT-O152A	Position Feedback	Ozone Generator GEN-O150A Outlet Flow Control Valve Position	WO-P0007							AI	
1332	O	YB-O159A	Close Command	Liquid Oxygen to Ozone Generator GEN-O150A Flow Control Valve Close	WO-P0007							DO	
1333	O	YD-O159A	Open Command	Liquid Oxygen to Ozone Generator GEN-O150A Flow Control Valve Open	WO-P0007							DO	
1334	O	YS-O159A	C/O/H Switch in Computer Position	Liquid Oxygen to Ozone Generator GEN-O150A Flow Control Valve in Computer Mode	WO-P0007							DI	
1335	O	ZB-O159A	Closed Status	Liquid Oxygen to Ozone Generator GEN-O150A Flow Control Valve Closed	WO-P0007							DI	
1336	O	ZD-O159A	Open Status	Liquid Oxygen to Ozone Generator GEN-O150A Flow Control Valve Open	WO-P0007							DI	
1337	O	YB-O201A	Close Command	Ozone Generator GEN-O110A to Ozone Contactor #2 Control Valve Close	WO-P0008							DO	
1338	O	YD-O201A	Open Command	Ozone Generator GEN-O110A to Ozone Contactor #2 Control Valve Open	WO-P0008							DI	
1339	O	YS-O201A	C/O/H Switch in Computer Position	Ozone Generator GEN-O110A to Ozone Contactor #2 Control Valve in Computer Mode	WO-P0008							DI	
1340	O	ZB-O201A	Closed Status	Ozone Generator GEN-O110A to Ozone Contactor #2 Control Valve Closed	WO-P0008							DI	
1341	O	ZD-O201A	Open Status	Ozone Generator GEN-O110A to Ozone Contactor #2 Control Valve Open	WO-P0008							DI	
1342	O	YB-O202A	Close Command	Ozone Generator GEN-O110A to Ozone Contactor #1 Control Valve Close	WO-P0008							DO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1343	O	YD-O202A	Open Command	Ozone Generator GEN-O110A to Ozone Contactor #1 Control Valve Open	WO-P0008							DI	
1344	O	YS-O202A	C/O/H Switch in Computer Position	Ozone Generator GEN-O110A to Ozone Contactor #1 Control Valve in Computer Mode	WO-P0008							DI	
1345	O	ZB-O202A	Closed Status	Ozone Generator GEN-O110A to Ozone Contactor #1 Control Valve Closed	WO-P0008							DI	
1346	O	ZD-O202A	Open Status	Ozone Generator GEN-O110A to Ozone Contactor #1 Control Valve Open	WO-P0008							DI	
1347	O	YB-O210A	Close Command	Ozone Contactor TK-O210A Inlet Sluice Gate Close	WO-P0010							DO	
1348	O	YD-O210A	Open Command	Ozone Contactor TK-O210A Inlet Sluice Gate Open	WO-P0010							DO	
1349	O	YS-O210A	C/O/H Switch in Computer Position	Ozone Contactor TK-O210A Inlet Sluice Gate in Computer Mode	WO-P0010							DI	
1350	O	YB-O210B	Close Command	Ozone Contactor TK-O210A Outlet Sluice Gate Close	WO-P0010							DO	
1351	O	YD-O210B	Open Command	Ozone Contactor TK-O210A Outlet Sluice Gate Open	WO-P0010							DO	
1352	O	YS-O210B	C/O/H Switch in Computer Position	Ozone Contactor TK-O210A Outlet Sluice Gate in Computer Mode	WO-P0010							DI	
1353	O	YB-O210C	Close Command	Ozone Contactor TK-O210A Outlet Sluice Gate Close	WO-P0010							DO	
1354	O	YD-O210C	Open Command	Ozone Contactor TK-O210A Outlet Sluice Gate Open	WO-P0010							DO	
1355	O	YS-O210C	C/O/H Switch in Computer Position	Ozone Contactor TK-O210A Outlet Sluice Gate in Computer Mode	WO-P0010							DI	
1356	O	ZB-O210A	Closed Status	Ozone Contactor TK-O210A Inlet Sluice Gate Closed	WO-P0010							DI	
1357	O	ZD-O210A	Open Status	Ozone Contactor TK-O210A Inlet Sluice Gate Open	WO-P0010							DI	
1358	O	ZB-O210B	Closed Status	Ozone Contactor TK-O210A Outlet Sluice Gate Closed	WO-P0010							DI	
1359	O	ZD-O210B	Open Status	Ozone Contactor TK-O210A Outlet Sluice Gate Open	WO-P0010							DI	
1360	O	ZB-O210C	Closed Status	Ozone Contactor TK-O210A Outlet Sluice Gate Closed	WO-P0010							DI	
1361	O	ZD-O210C	Open Status	Ozone Contactor TK-O210A Outlet Sluice Gate Open	WO-P0010							DI	
1362	O	FI-O216A	Flow Indication	Ozone Injection Line to Ozone Contactor #1 Flow Rate	WO-P0008							AI	
1363	O	FQ-O216A	Flow Pulse	Ozone Injection Line to Ozone Contactor #1 Flow Total	WO-P0008							DI	
1364	O	YS-O216A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve in Computer Mode	WO-P0008							DI	
1365	O	ZB-O216A	Closed Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Closed	WO-P0008							DI	
1366	O	ZC-O216A	Position Control Output	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Required Position	WO-P0008							AO	
1367	O	ZD-O216A	Open Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Open	WO-P0008							DI	
1368	O	ZT-O216A	Position Feedback	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Position	WO-P0008							AI	
1369	O	FI-O217A	Flow Indication	Ozone Injection Line to Ozone Contactor #1 Flow Rate	WO-P0008							AI	
1370	O	FQ-O217A	Flow Pulse	Ozone Injection Line to Ozone Contactor #1 Flow Total	WO-P0008							DI	
1371	O	YS-O217A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve in Computer Mode	WO-P0008							DI	
1372	O	ZB-O217A	Closed Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Closed	WO-P0008							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1373	O	ZC-O217A	Position Control Output	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Required Position	WO-P0008							AO	
1374	O	ZD-O217A	Open Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Open	WO-P0008							DI	
1375	O	ZT-O217A	Position Feedback	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Position	WO-P0008							AI	
1376	O	FI-O218A	Flow Indication	Ozone Injection Line to Ozone Contactor #1 Flow Rate	WO-P0008							AI	
1377	O	FQ-O218A	Flow Pulse	Ozone Injection Line to Ozone Contactor #1 Flow Total	WO-P0008							DI	
1378	O	YS-O218A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve in Computer Mode	WO-P0008							DI	
1379	O	ZB-O218A	Closed Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Closed	WO-P0008							DI	
1380	O	ZC-O218A	Position Control Output	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Required Position	WO-P0008							AO	
1381	O	ZD-O218A	Open Status	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Open	WO-P0008							DI	
1382	O	ZT-O218A	Position Feedback	Ozone Injection Line to Ozone Contactor #1 Flow Control Valve Position	WO-P0008							AI	
1383	O	FI-O220A	Flow Indication	Sample Element SE-0210A Dissolved Ozone Sample Flow Rate	WO-P0022							AI	
1384	O	FQ-O220A	Flow Pulse	Sample Element SE-0210A Dissolved Ozone Sample Total	WO-P0022							DI	
1385	O	MM-O220A	Running Status	Sample Element SE-0210A Dissolved Ozone Sample Pump Running	WO-P0022							DI	
1386	O	MN-O220A	Start Command	Sample Element SE-0210A Dissolved Ozone Sample Pump Start	WO-P0022							DO	
1387	O	UF-O220A	No Fault	Sample Element SE-0210A Dissolved Ozone Sample Pump Fault	WO-P0022							DI	
1388	O	YS-O220A	C/O/H Switch in Computer Position	Sample Element SE-0210A Dissolved Ozone Sample Pump in Computer Mode	WO-P0022							DI	
1389	O	AI-O221A	Ozone Indication	Sample Element SE-0210A Dissolved Ozone	WO-P0022							AI	
1390	O	FA-O222A	Flow Alarm	Sample Element SE-0210A Dissolved Ozone Sample Low Flow	WO-P0022							DI	
1391	O	FI-O225A	Flow Indication	Sample Element SE-0210B Dissolved Ozone Sample Flow Rate	WO-P0022							AI	
1392	O	FQ-O225A	Flow Pulse	Sample Element SE-0210B Dissolved Ozone Sample Flow Total	WO-P0022							DI	
1393	O	MM-O225A	Running Status	Sample Element SE-0210B Dissolved Ozone Sample Pump Running	WO-P0022							DI	
1394	O	MN-O225A	Start Command	Sample Element SE-0210B Dissolved Ozone Sample Pump Start	WO-P0022							DO	
1395	O	UF-O225A	No Fault	Sample Element SE-0210B Dissolved Ozone Sample Pump Fault	WO-P0022							DI	
1396	O	YS-O225A	C/O/H Switch in Computer Position	Sample Element SE-0210B Dissolved Ozone Sample Pump in Computer Mode	WO-P0022							DI	
1397	O	AI-O226A	Ozone Indication	Sample Element SE-0210B Dissolved Ozone	WO-P0022							AI	
1398	O	FA-O227A	Flow Alarm	Sample Element SE-0210B Dissolved Ozone Sample Low Flow	WO-P0022							DI	
1399	O	YB-O230A	Close Command	Ozone Contactor TK-O230A Inlet Sluice Gate Close	WO-P0011							DO	
1400	O	YD-O230A	Open Command	Ozone Contactor TK-O230A Inlet Sluice Gate Open	WO-P0011							DO	
1401	O	YS-O230A	C/O/H Switch in Computer Position	Ozone Contactor TK-O230A Inlet Sluice Gate in Computer Mode	WO-P0011							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1402	O	YB-O230B	Close Command	Ozone Contactor TK-O230A Outlet Sluice Gate Close	WO-P0011							DO	
1403	O	YD-O230B	Open Command	Ozone Contactor TK-O230A Outlet Sluice Gate Open	WO-P0011							DO	
1404	O	YS-O230B	C/O/H Switch in Computer Position	Ozone Contactor TK-O230A Outlet Sluice Gate in Computer Mode	WO-P0011							DI	
1405	O	YB-O230C	Close Command	Ozone Contactor TK-O230A Outlet Sluice Gate Close	WO-P0011							DO	
1406	O	YD-O230C	Open Command	Ozone Contactor TK-O230A Outlet Sluice Gate Open	WO-P0011							DO	
1407	O	YS-O230C	C/O/H Switch in Computer Position	Ozone Contactor TK-O230A Outlet Sluice Gate in Computer Mode	WO-P0011							DI	
1408	O	ZB-O230A	Closed Status	Ozone Contactor TK-O230A Inlet Sluice Gate Closed	WO-P0011							DI	
1409	O	ZD-O230A	Open Status	Ozone Contactor TK-O230A Inlet Sluice Gate Open	WO-P0011							DI	
1410	O	ZB-O230B	Closed Status	Ozone Contactor TK-O230A Outlet Sluice Gate Closed	WO-P0011							DI	
1411	O	ZD-O230B	Open Status	Ozone Contactor TK-O230A Outlet Sluice Gate Open	WO-P0011							DI	
1412	O	ZB-O230C	Closed Status	Ozone Contactor TK-O230A Outlet Sluice Gate Closed	WO-P0011							DI	
1413	O	ZD-O230C	Open Status	Ozone Contactor TK-O230A Outlet Sluice Gate Open	WO-P0011							DI	
1414	O	FI-O236A	Flow Indication	Ozone Injection Line to Ozone Contactor #2 Flow	WO-P0009							AI	
1415	O	FQ-O236A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #2 Flow	WO-P0009							DI	
1416	O	YS-O236A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve in Computer Mode	WO-P0009							DI	
1417	O	ZB-O236A	Closed Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Closed	WO-P0009							DI	
1418	O	ZC-O236A	Position Control Output	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Required Position	WO-P0009							AO	
1419	O	ZD-O236A	Open Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Open	WO-P0009							DI	
1420	O	ZT-O236A	Position Feedback	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Position	WO-P0009							AI	
1421	O	FI-O237A	Flow Indication	Ozone Injection Line to Ozone Contactor #2 Flow Rate	WO-P0009							AI	
1422	O	FQ-O237A	Flow Pulse	Ozone Injection Line to Ozone Contactor #2 Flow	WO-P0009							DI	
1423	O	YS-O237A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve in Computer Mode	WO-P0009							DI	
1424	O	ZB-O237A	Closed Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Closed	WO-P0009							DI	
1425	O	ZC-O237A	Position Control Output	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Required Position	WO-P0009							AO	
1426	O	ZD-O237A	Open Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Open	WO-P0009							DI	
1427	O	ZT-O237A	Position Feedback	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Position	WO-P0009							AI	
1428	O	FI-O238A	Flow Indication	Ozone Injection Line to Ozone Contactor #2 Flow Rate	WO-P0009							AI	
1429	O	FQ-O238A	Flow Pulse	Ozone Injection Line to Ozone Contactor #2 Flow Total	WO-P0009							DI	
1430	O	YS-O238A	C/O/H Switch in Computer Position	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve in Computer Mode	WO-P0009							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1431	O	ZB-O238A	Closed Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Closed	WO-P0009							DI	
1432	O	ZC-O238A	Position Control Output	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Required Position	WO-P0009							AO	
1433	O	ZD-O238A	Open Status	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Open	WO-P0009							DI	
1434	O	ZT-O238A	Position Feedback	Ozone Injection Line to Ozone Contactor #2 Flow Control Valve Position	WO-P0009							AI	
1435	O	FI-O240A	Flow Indication	Sample Element SE-0230A Dissolved Ozone Sample Flow Rate	WO-P0023							AI	
1436	O	FQ-O240A	Flow Pulse	Sample Element SE-0230A Dissolved Ozone Sample Total	WO-P0023							DI	
1437	O	MM-O240A	Running Status	Sample Element SE-0230A Dissolved Ozone Sample Pump Running	WO-P0023							DI	
1438	O	MN-O240A	Start Command	Sample Element SE-0230A Dissolved Ozone Sample Pump Start	WO-P0023							DO	
1439	O	UF-O240A	No Fault	Sample Element SE-0230A Dissolved Ozone Sample Pump Fault	WO-P0023							DI	
1440	O	YS-O240A	C/O/H Switch in Computer Position	Sample Element SE-0230A Dissolved Ozone Sample Pump in Computer Mode	WO-P0023							DI	
1441	O	AI-O241A	Ozone Indication	Sample Element SE-0230A Dissolved Ozone	WO-P0023							AI	
1442	O	FA-O242A	Flow Alarm	Sample Element SE-0230A Dissolved Ozone Sample Low Flow	WO-P0023							DI	
1443	O	FI-O245A	Flow Indication	Sample Element SE-0230B Dissolved Ozone Sample Flow Rate	WO-P0023							AI	
1444	O	FQ-O245A	Flow Pulse	Sample Element SE-0230B Dissolved Ozone Sample Flow Total	WO-P0023							DI	
1445	O	MM-O245A	Running Status	Sample Element SE-0230B Dissolved Ozone Sample Pump Running	WO-P0023							DI	
1446	O	MN-O245A	Start Command	Sample Element SE-0230B Dissolved Ozone Sample Pump Start	WO-P0023							DO	
1447	O	UF-O245A	No Fault	Sample Element SE-0230B Dissolved Ozone Sample Pump Fault	WO-P0023							DI	
1448	O	YS-O245A	C/O/H Switch in Computer Position	Sample Element SE-0230B Dissolved Ozone Sample Pump in Computer Mode	WO-P0023							DI	
1449	O	AI-O246A	Ozone Indication	Sample Element SE-0230B Dissolved Ozone	WO-P0023							AI	
1450	O	FA-O247A	Flow Alarm	Sample Element SE-0230B Dissolved Ozone Sample Low Flow	WO-P0023							DI	
1451	O	TA-O310A	Temperature Switch	Electrolyser Power Supply Unit PSU-O310A High Temperature	WO-P0019							DI	
1452	O	YD-O310A	Open Command	Open Loop Cooling Water to Power Supply Unit PSU-O310A Flow Control	WO-P0019							DO	
1453	O	TA-O320A	Temperature Switch	Electrolyser Power Supply Unit PSU-O320A High Temperature	WO-P0020							DI	
1454	O	YD-O320A	Open Command	Open Loop Cooling Water to Power Supply Unit PSU-O320A Flow Control	WO-P0020							DO	
1455	O	TA-O330A	Temperature Switch	Electrolyser Power Supply Unit PSU-O330A High Temperature	WO-P0021							DI	
1456	O	YD-O330A	Open Command	Open Loop Cooling Water to Power Supply Unit PSU-O330A Flow Control	WO-P0021							DO	
1457	O	MM-O401A	Running Status	Ozonation Open Loop Cooling Water Pump P-PO401A Running	WO-P0015							DI	
1458	O	MN-O401A	Start Command	Ozonation Open Loop Cooling Water Pump P-PO401A Start	WO-P0015							DO	
1459	O	UF-O401A	No Fault	Ozonation Open Loop Cooling Water Pump P-PO401A Fault	WO-P0015							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1460	O	YS-O401A	C/O/H Switch in Computer Position	Ozonation Open Loop Cooling Water Pump P-PO401A in Computer Mode	WO-P0015							DI	
1461	O	MM-O402A	Running Status	Ozonation Open Loop Cooling Water Pump P-PO402A Running	WO-P0015							DI	
1462	O	MN-O402A	Start Command	Ozonation Open Loop Cooling Water Pump P-PO402A Start	WO-P0015							DO	
1463	O	UF-O402A	No Fault	Ozonation Open Loop Cooling Water Pump P-PO402A Fault	WO-P0015							DI	
1464	O	YS-O402A	C/O/H Switch in Computer Position	Ozonation Open Loop Cooling Water Pump P-PO402A in Computer Mode	WO-P0015							DI	
1465	O	MM-O403A	Running Status	Ozonation Open Loop Cooling Water Pump P-PO403A Running	WO-P0015							DI	
1466	O	MN-O403A	Start Command	Ozonation Open Loop Cooling Water Pump P-PO403A Start	WO-P0015							DO	
1467	O	UF-O403A	No Fault	Ozonation Open Loop Cooling Water Pump P-PO403A Fault	WO-P0015							DI	
1468	O	YS-O403A	C/O/H Switch in Computer Position	Ozonation Open Loop Cooling Water Pump P-PO403A in Computer Mode	WO-P0015							DI	
1469	O	AI-O404A	Turbidity Indication	Open Loop Cooling Water Turbidity	WO-P0015							AI	
1470	O	FA-O404A	Flow Switch	Open Loop Cooling Water to Turbidity Analyzer Low Flow	WO-P0015							DI	
1471	O	FI-O410A	Flow Indication	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Flow Rate	WO-P0016							AI	
1472	O	FQ-O410A	Flow Pulse	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Flow Total	WO-P0016							DI	
1473	O	TI-O410A	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Temperature	WO-P0016							AI	
1474	O	TI-O410B	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O410A Outlet Temperature	WO-P0016							AI	
1475	O	YB-O410A	Close Command	Open Loop Cooling Water to Heat Exchanger HEX-O410A Valve Close	WO-P0016							DO	
1476	O	YD-O410A	Open Command	Open Loop Cooling Water to Heat Exchanger HEX-O410A Valve Open	WO-P0016							DO	
1477	O	YS-O410A	C/O/H Switch in Computer Position	Open Loop Cooling Water to Heat Exchanger HEX-O410A Valve in Computer Mode	WO-P0016							DI	
1478	O	ZB-O410A	Closed Status	Open Loop Cooling Water to Heat Exchanger HEX-O410A Valve Closed	WO-P0016							DI	
1479	O	ZD-O410A	Open Status	Open Loop Cooling Water to Heat Exchanger HEX-O410A Valve Open	WO-P0016							DI	
1480	O	CI-O411A	Conductivity Indication	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Outlet Conductivity	WO-P0016							AI	
1481	O	MM-O411A	Running Status	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Running	WO-P0016							DI	
1482	O	MN-O411A	Start Command	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Start	WO-P0016							DO	
1483	O	TI-O411A	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Temperature	WO-P0016							AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1484	O	TI-O411B	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Outlet Temperature	WO-P0016							AI	
1485	O	UF-O411A	No Fault	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Fault	WO-P0016							DI	
1486	O	YD-O411A	Open Command	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0410A Valve Open	WO-P0016							DO	
1487	O	YS-O411A	C/O/H Switch in Computer Position	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump in Computer Mode	WO-P0016							DI	
1488	O	FI-O420A	Flow Indication	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Flow Rate	WO-P0017							AI	
1489	O	FQ-O420A	Flow Pulse	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Flow Total	WO-P0017							DI	
1490	O	TI-O420A	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Temperature	WO-P0017							AI	
1491	O	TI-O420B	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O420A Outlet Temperature	WO-P0017							AI	
1492	O	YB-O420A	Close Command	Open Loop Cooling Water to Heat Exchanger HEX-O420A Valve Close	WO-P0017							DO	
1493	O	YD-O420A	Open Command	Open Loop Cooling Water to Heat Exchanger HEX-O420A Valve Open	WO-P0017							DO	
1494	O	YS-O420A	C/O/H Switch in Computer Position	Open Loop Cooling Water to Heat Exchanger HEX-O420A Valve in Computer Mode	WO-P0017							DI	
1495	O	ZB-O420A	Closed Status	Open Loop Cooling Water to Heat Exchanger HEX-O420A Valve Closed	WO-P0017							DI	
1496	O	ZD-O420A	Open Status	Open Loop Cooling Water to Heat Exchanger HEX-O420A Valve Open	WO-P0017							DI	
1497	O	CI-O421A	Conductivity Indication	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Outlet Conductivity	WO-P0017							AI	
1498	O	MM-O421A	Running Status	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Running	WO-P0017							DI	
1499	O	MN-O421A	Start Command	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Start	WO-P0017							DO	
1500	O	TI-O421A	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Inlet Temperature	WO-P0017							AI	
1501	O	TI-O421B	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420 Outlet Temperature	WO-P0017							AI	
1502	O	UF-O421A	No Fault	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Fault	WO-P0017							DI	
1503	O	YD-O421A	Open Command	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0420A Valve Open	WO-P0017							DO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1504	O	YS-O421A	C/O/H Switch in Computer Position	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump in Computer Mode	WO-P0017							DI	
1505	O	FI-O430A	Flow Indication	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Flow Rate	WO-P0018							AI	
1506	O	FQ-O430A	Flow Pulse	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Flow Total	WO-P0018							DI	
1507	O	TI-O430A	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Temperature	WO-P0018							AI	
1508	O	TI-O430B	Temperature Indication	Open Loop Cooling Water to Heat Exchanger HEX-O430A Outlet Temperature	WO-P0018							AI	
1509	O	YB-O430A	Close Command	Open Loop Cooling Water to Heat Exchanger HEX-O430A Valve Close	WO-P0018							DO	
1510	O	YD-O430A	Open Command	Open Loop Cooling Water to Heat Exchanger HEX-O430A Valve Open	WO-P0018							DO	
1511	O	YS-O430A	C/O/H Switch in Computer Position	Open Loop Cooling Water to Heat Exchanger HEX-O430A Valve in Computer Mode	WO-P0018							DI	
1512	O	ZB-O430A	Closed Status	Open Loop Cooling Water to Heat Exchanger HEX-O430A Valve Closed	WO-P0018							DI	
1513	O	ZD-O430A	Open Status	Open Loop Cooling Water to Heat Exchanger HEX-O430A Valve Open	WO-P0018							DI	
1514	O	CI-O431A	Conductivity Indication	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Outlet Conductivity	WO-P0018							AI	
1515	O	MM-O431A	Running Status	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Running	WO-P0018							DI	
1516	O	MN-O431A	Start Command	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Start	WO-P0018							DO	
1517	O	TI-O431A	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Inlet Temperature	WO-P0018							AI	
1518	O	TI-O431B	Temperature Indication	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430 Outlet Temperature	WO-P0018							AI	
1519	O	UF-O431A	No Fault	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Fault	WO-P0018							DI	
1520	O	YD-O431A	Open Command	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0430A Valve Open	WO-P0018							DO	
1521	O	YS-O431A	C/O/H Switch in Computer Position	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump in Computer Mode	WO-P0018							DI	
1522	O	AI-O505A	Ozone Gas Indication	Ozone Contactor #2 to Ozone Destruct Analyzer	WO-P0014							AI	
1523	O	PI-O505A	Pressure Indication	Ozone Contactor #2 to Ozone Destruct Units Pressure	WO-P0014							AI	
1524	O	PI-O505B	Pressure Indication	Ozone Contactor #2 to Ozone Destruct Units Demister Differential Pressure	WO-P0014							AI	
1525	O	AI-O510A	Ozone Gas Indication	Ozone Contactor #1 to Ozone Destruct Gas Level	WO-P0012							AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1526	O	AI-O510B	Ozone Gas Indication	Ozone Destruct Unit #1 Vent Ozone Gas Level	WO-P0012							AI	
1527	O	MM-O510A	Running Status	Ozone Destruct Unit #1 Blower Running	WO-P0012							DI	
1528	O	MN-O510A	Start Command	Ozone Destruct Unit #1 Blower Start	WO-P0012							DO	
1529	O	PI-O510A	Pressure Indication	Ozone Contactor #1 to Ozone Destruct Units Pressure	WO-P0012							AI	
1530	O	PI-O510A	Pressure Indicator Transmitter	Catalytic Destruct Unit CDU-O510 Differential Pressure	WO-P0012							AI	
1531	O	PI-O510B	Pressure Indication	Ozone Contactor #1 to Ozone Destruct Units Demister Differential Pressure	WO-P0012							AI	
1532	O	PI-O510B	Pressure Indicator Transmitter	Ozone Destruct Unit #1 Blower Differential Pressure	WO-P0012							AI	
1533	O	TI-O510A	Temperature Indication	Ozone Destruct Unit #1 Heater Inlet Temperature	WO-P0012							AI	
1534	O	TI-O510B	Temperature Indication	Ozone Destruct Unit #1 Heater Outlet Temperature	WO-P0012							AI	
1535	O	TI-O510C	Temperature Indication	Catalytic Destruct Unit CDU-O510A Outlet Temperature	WO-P0012							AI	
1536	O	UF-O510A	No Fault	Ozone Destruct Unit #1 Blower Fault	WO-P0012							DI	
1537	O	YS-O510A	C/O/H Switch in Computer Position	Ozone Destruct Unit #1 Inlet Valve in Computer Mode	WO-P0012							DI	
1538	O	YS-O510A	C/O/H Switch in Computer Position	Ozone Destruct Unit #1 Blower in Computer Mode	WO-P0012							DI	
1539	O	ZB-O510A	Closed Status	Ozone Destruct Unit #1 Inlet Valve Closed	WO-P0012							DI	
1540	O	ZC-O510A	Position Control Output	Ozone Destruct Unit #1 Inlet Valve Required Position	WO-P0012							DO	
1541	O	ZD-O510A	Open Status	Ozone Destruct Unit #1 Inlet Valve Open	WO-P0012							DI	
1542	O	ZT-O510A	Position Feedback	Ozone Destruct Unit #1 Inlet Valve Position	WO-P0012							DO	
1543	O	AI-O520A	Ozone Gas Indication	Ozone Destruct Unit #2 Vent Ozone Gas Level	WO-P0013							AI	
1544	O	AI-O520B	Ozone Gas Indication	Ambient Ozone Gas Level	WO-P0013							AI	
1545	O	MM-O520A	Running Status	Ozone Destruct Unit #2 Blower Running	WO-P0013							DI	
1546	O	MN-O520A	Start Command	Ozone Destruct Unit #2 Blower Start	WO-P0013							DO	
1547	O	PI-O520A	Pressure Indication	Catalytic Destruct Unit CDU-O520A Differential Pressure	WO-P0013							AI	
1548	O	PI-O520B	Pressure Indication	Ozone Destruct Unit #2 Blower Differential Pressure	WO-P0013							AI	
1549	O	TI-O520A	Temperature Indication	Ozone Destruct Unit #2 Heater Inlet Temperature	WO-P0013							AI	
1550	O	TI-O520B	Temperature Indication	Ozone Destruct Unit #2 Heater Outlet Temperature	WO-P0013							AI	
1551	O	TI-O520C	Temperature Indication	Catalytic Destruct Unit CDU-O520A Outlet Temperature	WO-P0013							AI	
1552	O	UF-O520A	No Fault	Ozone Destruct Unit #2 Blower Fault	WO-P0013							DI	
1553	O	YS-O520A	C/O/H Switch in Computer Position	Ozone Destruct Unit #2 Inlet Valve in Computer Mode	WO-P0013							DI	
1554	O	YS-O520A	C/O/H Switch in Computer Position	Ozone Destruct Unit #2 Blower in Computer Mode	WO-P0013							DI	
1555	O	ZB-O520A	Closed Status	Ozone Destruct Unit #2 Inlet Valve Closed	WO-P0013							DI	
1556	O	ZC-O520A	Position Control Output	Ozone Destruct Unit #2 Inlet Valve Required Position	WO-P0013							DO	
1557	O	ZD-O520A	Open Status	Ozone Destruct Unit #2 Inlet Valve Open	WO-P0013							DI	
1558	O	ZT-O520A	Position Feedback	Ozone Destruct Unit #2 Inlet Valve Position	WO-P0013							DO	
1559	O	YB-O521A	Close Command	Ozone Destruct Unit #1 Bypass Close	WO-P0012							DO	
1560	O	YD-O521A	Open Command	Ozone Destruct Unit #1 Bypass Open	WO-P0012							DO	
1561	O	YS-O521A	C/O/H Switch in Computer Position	Ozone Destruct Unit #1 Bypass in Computer Mode	WO-P0012							DI	
1562	O	ZB-O521A	Closed Status	Ozone Destruct Unit #1 Bypass Closed	WO-P0012							DI	
1563	O	ZD-O521A	Open Status	Ozone Destruct Unit #1 Bypass Open	WO-P0012							DI	
1564	O	YB-O523A	Close Command	Ozone Destruct Unit #3 Bypass Valve Close	WO-P0014							DO	
1565	O	YD-O523A	Open Command	Ozone Destruct Unit #3 Bypass Valve Open	WO-P0014							DO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1566	O	YS-O523A	C/O/H Switch in Computer Position	Ozone Destruct Unit #3 Bypass Valve in Computer Mode	WO-P0014							DI	
1567	O	ZB-O523A	Closed Status	Ozone Destruct Unit #3 Bypass Valve Closed	WO-P0014							DI	
1568	O	ZD-O523A	Open Status	Ozone Destruct Unit #3 Bypass Valve Open	WO-P0014							DI	
1569	O	AI-O530A	Ozone Gas Indication	Ozone Destruct Unit #3 Vent Ozone Analyzer Gas Level	WO-P0014							AI	
1570	O	MM-O530A	Running Status	Ozone Destruct Unit #3 Blower Running	WO-P0014							DI	
1571	O	MN-O530A	Start Command	Ozone Destruct Unit #3 Blower Start	WO-P0014							DO	
1572	O	PI-O530A	Pressure Indication	Catalytic Destruct Unit CDU-O530 Differential Pressure	WO-P0014							AI	
1573	O	PI-O530B	Pressure Indication	Ozone Destruct Unit #3 Blower Differential Pressure	WO-P0014							AI	
1574	O	TI-O530A	Temperature Indication	Ozone Destruct Unit #3 Heater Inlet Temperature	WO-P0014							AI	
1575	O	TI-O530B	Temperature Indication	Ozone Destruct Unit #3 Heater Outlet Temperature	WO-P0014							AI	
1576	O	TI-O530C	Temperature Indication	Catalytic Destruct Unit CDU-O530A Outlet Temperature	WO-P0014							AI	
1577	O	UF-O530A	No Fault	Ozone Destruct Unit #3 Blower Fault	WO-P0014							DI	
1578	O	YS-O530A	C/O/H Switch in Computer Position	Ozone Destruct Unit #3 Inlet Valve in Computer Mode	WO-P0014							DI	
1579	O	YS-O530A	C/O/H Switch in Computer Position	Ozone Destruct Unit #3 Blower in Computer Mode	WO-P0014							DI	
1580	O	ZB-O530A	Closed Status	Ozone Destruct Unit #3 Inlet Valve Closed	WO-P0014							DI	
1581	O	ZC-O530A	Position Control Output	Ozone Destruct Unit #3 Inlet Valve Required Position	WO-P0014							AO	
1582	O	ZD-O530A	Open Status	Ozone Destruct Unit #3 Inlet Valve Open	WO-P0014							DI	
1583	O	ZT-O530A	Position Feedback	Ozone Destruct Unit #3 Inlet Valve Position	WO-P0014							AI	
1584	O	PI-OO31A	Pressure Indication	Liquid Oxygen Particle Filter GFO031 Differential Pressure	WO-P0003						CP-O30	AI	
1585	O	FI-P001A	Flow Indication	DAF Recycle Water Flow Rate to Saturator P001A	WP-P0013							AI	
1586	O	FQ-P001A	Flow Pulse	DAF Recycle Water Flow Total to Saturator P001A	WP-P0013							DI	
1587	O	LI-P001A	Level Indication	DAF Saturator Vessel P001A Level	WP-P0013							AI	
1588	O	LS-P001A	Level Switch	DAF Saturator Vessel P001A Level Low	WP-P0013							DI	
1589	O	PI-P001A	Pressure Indication	DAF Saturator Vessel P001A Pressure	WP-P0013							AI	
1590	O	PS-P001A	Pressure Switch	DAF Saturator Vessel P001A Pressure Low	WP-P0013							AI	
1591	O	TI-P001A	Temperature Indication	DAF Saturator Vessel P001A Temperature	WP-P0013							AI	
1592	O	ZB-P001A	Closed Status	DAF Saturator Vessel P001A Outlet Flow Shutoff Valve Closed	WP-P0013							DI	
1593	O	ZD-P001A	Open Status	DAF Saturator Vessel P001A Outlet Flow Shutoff Valve Open	WP-P0013							DI	
1594	O	FI-P002A	Flow Indication	DAF Recycle Water Flow Rate to Saturator P002A	WP-P0013							AI	
1595	O	FQ-P002A	Flow Pulse	DAF Recycle Water Flow Total to Saturator P002A	WP-P0013							DI	
1596	O	LI-P002A	Level Indication	DAF Saturator Vessel P002A Level	WP-P0013							AI	
1597	O	LS-P002A	Level Switch	DAF Saturator Vessel P002A Level Low	WP-P0013							DI	
1598	O	PI-P002A	Pressure Indicator Transmitter	DAF Saturator Vessel P002A Pressure	WP-P0013							AI	
1599	O	PS-P002A	Pressure Switch	DAF Saturator Vessel P002A Pressure Low	WP-P0013							AI	
1600	O	TI-P002A	Temperature Indicator Transmitter	DAF Saturator Vessel P002A Temperature	WP-P0013							AI	
1601	O	ZB-P002A	Closed Status	DAF Saturator Vessel P002A Outlet Flow Shutoff Valve Closed	WP-P0013							DI	
1602	O	ZD-P002A	Open Status	DAF Saturator Vessel P002A Outlet Flow Shutoff Valve Open	WP-P0013							DI	
1603	O	FI-P003A	Flow Indication	DAF Recycle Water Flow Rate to Saturator P003A	WP-P0014							AI	
1604	O	FQ-P003A	Flow Pulse	DAF Recycle Water Flow Total to Saturator P003A	WP-P0014							DI	
1605	O	LI-P003A	Level Indication	DAF Saturator Vessel P003A Level	WP-P0014							AI	
1606	O	LS-P003A	Level Switch	DAF Saturator Vessel P003A Level Low	WP-P0014							DI	

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PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1607	O	PI-P003A	Pressure Indicator Transmitter	DAF Saturator Vessel P003A Pressure	WP-P0014							AI	
1608	O	PS-P003A	Pressure Switch	DAF Saturator Vessel P003A Pressure Low	WP-P0014							AI	
1609	O	TI-P003A	Temperature Indicator Transmitter	DAF Saturator Vessel P003A Temperature	WP-P0014							AI	
1610	O	ZB-P003A	Closed Status	DAF Saturator Vessel P003A Outlet Flow Shutoff Valve Closed	WP-P0014							DI	
1611	O	ZD-P003A	Open Status	DAF Saturator Vessel P003A Outlet Flow Shutoff Valve Open	WP-P0014							DI	
1612	O	FI-P004A	Flow Indication	DAF Recycle Water Flow Rate to Saturator P004A	WP-P0014							AI	
1613	O	FQ-P004A	Flow Pulse	DAF Recycle Water Flow Total to Saturator P004A	WP-P0014							DI	
1614	O	LI-P004A	Level Indication	DAF Saturator Vessel P004A Level	WP-P0014							AI	
1615	O	LS-P004A	Level Switch	DAF Saturator Vessel P004A Level Low	WP-P0014							DI	
1616	O	PI-P004A	Pressure Indicator Transmitter	DAF Saturator Vessel P004A Pressure	WP-P0014							AI	
1617	O	PS-P004A	Pressure Switch	DAF Saturator Vessel P004A Pressure Low	WP-P0014							AI	
1618	O	TI-P004A	Temperature Indicator Transmitter	DAF Saturator Vessel P004A Temperature	WP-P0014							AI	
1619	O	ZB-P004A	Closed Status	DAF Saturator Vessel P004A Outlet Flow Shutoff Valve Closed	WP-P0014							DI	
1620	O	ZD-P004A	Open Status	DAF Saturator Vessel P004A Outlet Flow Shutoff Valve Open	WP-P0014							DI	
1621	O	IT-P010A	Current Indication	DAF Recycle Pump P-P010A Current	WP-P0012							AI TCP	
1622	O	MM-P010A	Running Status	DAF Recycle Pump P-P010A Running	WP-P0012							DI TCP	
1623	O	MN-P010A	Start Command	DAF Recycle Pump P-P010A Start	WP-P0012							DO TCP	
1624	O	SC-P010A	Speed Control Output	DAF Recycle Pump P-P010A Required Speed	WP-P0012							AO TCP	
1625	O	SI-P010A	Speed Indication	DAF Recycle Pump P-P010A Speed	WP-P0012							AI TCP	
1626	O	UF-P010A	No Fault	DAF Recycle Pump P-P010A Fault	WP-P0012							DI TCP	
1627	O	YS-P010A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P010A in Computer Mode	WP-P0012							DI TCP	
1628	O	ZB-P010C	Closed Status	DAF Recycle Pump P-P010A Discharge Valve Closed	WP-P0012							DI	
1629	O	ZD-P010C	Open Status	DAF Recycle Pump P-P010A Discharge Valve Open	WP-P0012							DI	
1630	O	IT-P020A	Current Indication	DAF Recycle Pump P-P020A Current	WP-P0012							AI TCP	
1631	O	MM-P020A	Running Status	DAF Recycle Pump P-P020A Running	WP-P0012							DI TCP	
1632	O	MN-P020A	Start Command	DAF Recycle Pump P-P020A Start	WP-P0012							DO TCP	
1633	O	SC-P020A	Speed Control Output	DAF Recycle Pump P-P020A Required Speed	WP-P0012							AO TCP	
1634	O	SI-P020A	Speed Indication	DAF Recycle Pump P-P020A Speed	WP-P0012							AI TCP	
1635	O	UF-P020A	No Fault	DAF Recycle Pump P-P020A Fault	WP-P0012							DI TCP	
1636	O	YS-P020A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P020A in Computer Mode	WP-P0012							DI TCP	
1637	O	YB-P020D	Close Command	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve Close	WP-P0012							DO	
1638	O	YD-P020D	Open Command	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve Open	WP-P0012							DO	
1639	O	YS-P020D	C/O/H Switch in Computer Position	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve in Computer Mode	WP-P0012							DI	
1640	O	YB-P020E	Close Command	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve Close	WP-P0012							DO	
1641	O	YD-P020E	Open Command	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve Open	WP-P0012							DO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1642	O	YS-P020E	C/O/H Switch in Computer Position	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve in Computer Mode	WP-P0012							DI	
1643	O	ZB-P020D	Closed Status	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve Closed	WP-P0012							DI	
1644	O	ZD-P020D	Open Status	Pump P-P020A (Common Standby) to DAF Saturator P001A Control Valve Open	WP-P0012							DI	
1645	O	ZB-P020E	Closed Status	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve Closed	WP-P0012							DI	
1646	O	ZD-P020E	Open Status	Pump P-P020A (Common Standby) to DAF Saturator P002A Control Valve Open	WP-P0012							DI	
1647	O	IT-P030A	Current Indication	DAF Recycle Pump P-P030A Current	WP-P0012							AI TCP	
1648	O	MM-P030A	Running Status	DAF Recycle Pump P-P030A Running	WP-P0012							DI TCP	
1649	O	MN-P030A	Start Command	DAF Recycle Pump P-P030A Start	WP-P0012							DO TCP	
1650	O	SC-P030A	Speed Control Output	DAF Recycle Pump P-P030A Required Speed	WP-P0012							AO TCP	
1651	O	SI-P030A	Speed Indication	DAF Recycle Pump P-P030A Speed	WP-P0012							AI TCP	
1652	O	UF-P030A	No Fault	DAF Recycle Pump P-P030A Fault	WP-P0012							DI TCP	
1653	O	YS-P030A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P030A in Computer Mode	WP-P0012							DI TCP	
1654	O	ZB-P030C	Closed Status	DAF Recycle Pump P030A Discharge Valve Closed	WP-P0012							DI	
1655	O	ZD-P030C	Open Status	DAF Recycle Pump P-P030A Discharge Valve Open	WP-P0012							DI	
1656	O	IT-P040A	Current Indication	DAF Recycle Pump P-P040A Current	WP-P0014							AI TCP	
1657	O	MM-P040A	Running Status	DAF Recycle Pump P-P040A Running	WP-P0014							DI TCP	
1658	O	MN-P040A	Start Command	DAF Recycle Pump P-P040A Start	WP-P0014							DO TCP	
1659	O	SC-P040A	Speed Control Output	DAF Recycle Pump P-P040A Required Speed	WP-P0014							AO TCP	
1660	O	SI-P040A	Speed Indication	DAF Recycle Pump P-P040A Speed	WP-P0014							AI TCP	
1661	O	UF-P040A	No Fault	DAF Recycle Pump P-P040A Fault	WP-P0014							DI TCP	
1662	O	YS-P040A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P040A in Computer Mode	WP-P0014							DI TCP	
1663	O	ZB-P040C	Closed Status	DAF Recycle Pump P-P040A Discharge Valve Closed	WP-P0014							DI	
1664	O	ZD-P040C	Open Status	DAF Recycle Pump P-P040A Discharge Valve Open	WP-P0014							DI	
1665	O	IT-P050A	Current Indication	DAF Recycle Pump P-P050A Current	WP-P0014							AI TCP	
1666	O	MM-P050A	Running Status	DAF Recycle Pump P-P050A Running	WP-P0014							DI TCP	
1667	O	MN-P050A	Start Command	DAF Recycle Pump P-P050A Start	WP-P0014							DO TCP	
1668	O	SC-P050A	Speed Control Output	DAF Recycle Pump P-P050A Required Speed	WP-P0014							AO TCP	
1669	O	SI-P050A	Speed Indication	DAF Recycle Pump P-P050A Speed	WP-P0014							AI TCP	
1670	O	UF-P050A	No Fault	DAF Recycle Pump P-P050A Fault	WP-P0014							DI TCP	
1671	O	YS-P050A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P050A in Computer Mode	WP-P0014							DI TCP	
1672	O	YB-P050D	Close Command	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve Close	WP-P0014							DO	
1673	O	YD-P050D	Open Command	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve Open	WP-P0014							DO	
1674	O	YS-P050D	C/O/H Switch in Computer Position	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve in Computer Mode	WP-P0014							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1675	O	YB-P050E	Close Command	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve Close	WP-P0014							DO	
1676	O	YD-P050E	Open Command	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve Open	WP-P0014							DO	
1677	O	YS-P050E	C/O/H Switch in Computer Position	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve in Computer Mode	WP-P0014							DI	
1678	O	ZB-P050D	Closed Status	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve Closed	WP-P0014							DI	
1679	O	ZD-P050D	Open Status	Pump P-P050A (Common Standby) to DAF Saturator P003A Control Valve Open	WP-P0014							DI	
1680	O	ZB-P050E	Closed Status	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve Closed	WP-P0014							DI	
1681	O	ZD-P050E	Open Status	Pump P-P050A (Common Standby) to DAF Saturator P004A Control Valve Open	WP-P0014							DI	
1682	O	IT-P060A	Current Indication	DAF Recycle Pump P-P060A Current	WP-P0014							AI TCP	
1683	O	MM-P060A	Running Status	DAF Recycle Pump P-P060A Running	WP-P0014							DI TCP	
1684	O	MN-P060A	Start Command	DAF Recycle Pump P-P060A Start	WP-P0014							DO TCP	
1685	O	SC-P060A	Speed Control Output	DAF Recycle Pump P-P060A Required Speed	WP-P0014							AO TCP	
1686	O	SI-P060A	Speed Indication	DAF Recycle Pump P-P060A Speed	WP-P0014							AI TCP	
1687	O	UF-P060A	No Fault	DAF Recycle Pump P-P060A Fault	WP-P0014							DI TCP	
1688	O	YS-P060A	C/O/H Switch in Computer Position	DAF Recycle Pump P-P060A in Computer Mode	WP-P0014							DI TCP	
1689	O	ZB-P060C	Closed Status	DAF Recycle Pump P-P060A Discharge Valve Closed	WP-P0014							DI	
1690	O	ZD-P060C	Open Status	DAF Recycle Pump P-P060A Discharge Valve Open	WP-P0014							DI	
1691	O	FI-P100A	Flow Indication	Raw Water Flow Rate to DAF TNKP100A	WP-P0002							AI	
1692	O	FQ-P100A	Flow Pulse	Raw Water Total Flow Rate to DAF TNKP100A	WP-P0002							DI	
1693	O	LF-P100A	No Fault	DAF TNKP100A Level Fault	WP-P0004							DI	
1694	O	LI-P100A	Level Indication	DAF TNKP100A Level	WP-P0004							AI	
1695	O	MF-P100A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P100A Travelled Reverse	WP-P0004							DI TCP	
1696	O	MM-P100A	Running Status	DAF Float Reciprocating Scraper FLC-P100A Running	WP-P0004							DI TCP	
1697	O	MN-P100A	Start Command	DAF Float Reciprocating Scraper FLC-P100A Start	WP-P0004							DO TCP	
1698	O	MR-P100A	Forward Limit	DAF Float Reciprocating Scraper FLC-P100A Travelled Forward	WP-P0004							DI TCP	
1699	O	SC-P100A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P100A Required Speed	WP-P0004							AO TCP	
1700	O	SI-P100A	Speed Indication	DAF Float Reciprocating Scraper FLC-P100A Speed	WP-P0004							AI TCP	
1701	O	UF-P100A	No Fault	DAF Float Reciprocating Scraper FLC-P100A Fault	WP-P0004							DI TCP	
1702	O	YS-P100A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP100A Valve in Computer Mode	WP-P0002							DI	
1703	O	YS-P100A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P100A in Computer Mode	WP-P0004							DI TCP	
1704	O	ZB-P100A	Closed Status	Raw Water Flow Control to DAF TNKP100A Valve Closed	WP-P0002							DI	
1705	O	ZC-P100A	Position Control Output	Raw Water Flow Control to DAF TNKP100A Valve Required Position	WP-P0002							AO	
1706	O	ZD-P100A	Open Status	Raw Water Flow Control to DAF TNKP100A Valve Open	WP-P0002							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1707	O	ZT-P100A	Position Feedback	Raw Water Flow Control to DAF TNKP100A Valve Position	WP-P0002							AI	
1708	O	MM-P101A	Running Status	DAF Flocculator FLC-P101A Running	WP-P0004							DI TCP	
1709	O	MN-P101A	Start Command	DAF Flocculator FLC-P101A Start	WP-P0004							DO TCP	
1710	O	SC-P101A	Speed Control Output	DAF Flocculator FLC-P101A Required Speed	WP-P0004							AO TCP	
1711	O	SI-P101A	Speed Indication	DAF Flocculator FLC-P101A Speed	WP-P0004							AI TCP	
1712	O	UF-P101A	No Fault	DAF Flocculator FLC-P101A Fault	WP-P0004							DI TCP	
1713	O	YS-P101A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P101A in Computer Mode	WP-P0004							DI TCP	
1714	O	MM-P102A	Running Status	DAF Flocculator FLC-P102A Running	WP-P0004							DI TCP	
1715	O	MN-P102A	Start Command	DAF Flocculator FLC-P102A Start	WP-P0004							DO TCP	
1716	O	SC-P102A	Speed Control Output	DAF Flocculator FLC-P102A Required Speed	WP-P0004							AO TCP	
1717	O	SI-P102A	Speed Indication	DAF Flocculator FLC-P102A Speed	WP-P0004							AI TCP	
1718	O	UF-P102A	No Fault	DAF Flocculator FLC-P102A Fault	WP-P0004							DI TCP	
1719	O	YS-P102A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P102A in Computer Mode	WP-P0004							DI TCP	
1720	O	MM-P103A	Running Status	DAF Flocculator FLC-P103A Running	WP-P0004							DI TCP	
1721	O	MN-P103A	Start Command	DAF Flocculator FLC-P103A Start	WP-P0004							DO TCP	
1722	O	SC-P103A	Speed Control Output	DAF Flocculator FLC-P103A Required Speed	WP-P0004							AO TCP	
1723	O	SI-P103A	Speed Indication	DAF Flocculator FLC-P103A Speed	WP-P0004							AI TCP	
1724	O	UF-P103A	No Fault	DAF Flocculator FLC-P103A Fault	WP-P0004							DI TCP	
1725	O	YS-P103A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P103A in Computer Mode	WP-P0004							DI TCP	
1726	O	MM-P104A	Running Status	DAF Flocculator FLC-P104A Running	WP-P0004							DI TCP	
1727	O	MN-P104A	Start Command	DAF Flocculator FLC-P104A Start	WP-P0004							DO TCP	
1728	O	SC-P104A	Speed Control Output	DAF Flocculator FLC-P104A Required Speed	WP-P0004							AO TCP	
1729	O	SI-P104A	Speed Indication	DAF Flocculator FLC-P104A Speed	WP-P0004							AI TCP	
1730	O	UF-P104A	No Fault	DAF Flocculator FLC-P104A Fault	WP-P0004							DI TCP	
1731	O	YS-P104A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P104A in Computer Mode	WP-P0004							DI TCP	
1732	O	MM-P105A	Running Status	DAF Flocculator FLC-P105A Running	WP-P0004							DI TCP	
1733	O	MN-P105A	Start Command	DAF Flocculator FLC-P105A Start	WP-P0004							DO TCP	
1734	O	SC-P105A	Speed Control Output	DAF Flocculator FLC-P105A Required Speed	WP-P0004							AO TCP	
1735	O	SI-P105A	Speed Indication	DAF Flocculator FLC-P105A Speed	WP-P0004							AI TCP	
1736	O	UF-P105A	No Fault	DAF Flocculator FLC-P105A Fault	WP-P0004							DI TCP	
1737	O	YS-P105A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P105A in Computer Mode	WP-P0004							DI TCP	
1738	O	MM-P106A	Running Status	DAF Flocculator FLC-P106A Running	WP-P0004							DI TCP	
1739	O	MN-P106A	Start Command	DAF Flocculator FLC-P106A Start	WP-P0004							DO TCP	
1740	O	SC-P106A	Speed Control Output	DAF Flocculator FLC-P106A Required Speed	WP-P0004							AO TCP	
1741	O	SI-P106A	Speed Indication	DAF Flocculator FLC-P106A Speed	WP-P0004							AI TCP	
1742	O	UF-P106A	No Fault	DAF Flocculator FLC-P106A Fault	WP-P0004							DI TCP	
1743	O	YS-P106A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P106A in Computer Mode	WP-P0004							DI TCP	
1744	O	YS-P110A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P100A Valve in Computer Mode	WP-P0004							DI	
1745	O	YS-P110B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P100A Valve in Computer Mode	WP-P0004							DI	
1746	O	ZB-P110A	Closed Status	Air Saturated Water to DAF TNK-P100A Valve Closed	WP-P0004							DI	
1747	O	ZC-P110A	Position Control Output	Air Saturated Water to DAF TNK-P100A Valve Required Position	WP-P0004							AO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1748	O	ZD-P110A	Open Status	Air Saturated Water to DAF TNK-P100A Valve Open	WP-P0004							DI	
1749	O	ZT-P110A	Position Feedback	Air Saturated Water to DAF TNK-P100A Valve Position	WP-P0004							AI	
1750	O	ZB-P110B	Closed Status	Air Saturated Water to DAF TNK-P100A Valve Closed	WP-P0004							DI	
1751	O	ZC-P110B	Position Control Output	Air Saturated Water to DAF TNK-P100A Valve Required Position	WP-P0004							AO	
1752	O	ZD-P110B	Open Status	Air Saturated Water to DAF TNK-P100A Valve Open	WP-P0004							DI	
1753	O	ZT-P110B	Position Feedback	Air Saturated Water to DAF TNK-P100A Valve Position	WP-P0004							AI	
1754	O	YD-P120A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP100A) Open	WP-P0004							DO	
1755	O	YD-P120B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP100A) Open	WP-P0004							DO	
1756	O	YS-P140A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP100A) in Computer Mode	WP-P0004							DI	
1757	O	ZB-P140A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP100A) Closed	WP-P0004							DI	
1758	O	ZC-P140A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP100A) Required Position	WP-P0004							AO	
1759	O	ZD-P140A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP100A) Open	WP-P0004							DI	
1760	O	ZT-P140A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP100A) Position	WP-P0004							AI	
1761	O	FI-P200A	Flow Indication	Raw Water Flow Rate to DAF TNKP200A	WP-P0002							AI	
1762	O	FQ-P200A	Flow Pulse	Raw Water Flow Total to DAF TNKP200A	WP-P0002							DI	
1763	O	LF-P200A	No Fault	DAF TNKP200A Level Fault	WP-P0005							DI	
1764	O	LI-P200A	Level Indication	DAF TNKP200A Level	WP-P0005							AI	
1765	O	MF-P200A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P200A Travelled Reverse	WP-P0005							DI TCP	
1766	O	MM-P200A	Running Status	DAF Float Reciprocating Scraper FLC-P200A Running	WP-P0005							DI TCP	
1767	O	MN-P200A	Start Command	DAF Float Reciprocating Scraper FLC-P200A Start	WP-P0005							DO TCP	
1768	O	MR-P200A	Forward Limit	DAF Float Reciprocating Scraper FLC-P200A Travelled Forward	WP-P0005							DI TCP	
1769	O	SC-P200A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P200A Required Speed	WP-P0005							AO TCP	
1770	O	SI-P200A	Speed Indication	DAF Float Reciprocating Scraper FLC-P200A Speed	WP-P0005							AI TCP	
1771	O	UF-P200A	No Fault	DAF Float Reciprocating Scraper FLC-P200A Fault	WP-P0005							DI TCP	
1772	O	YS-P200A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP200A Valve in Computer Mode	WP-P0002							DI	
1773	O	YS-P200A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P200A in Computer Mode	WP-P0005							DI TCP	
1774	O	ZB-P200A	Closed Status	Raw Water Flow Control to DAF TNKP200A Valve Closed	WP-P0002							DI	
1775	O	ZC-P200A	Position Control Output	Raw Water Flow Control to DAF TNKP200A Valve Required Position	WP-P0002							AO	
1776	O	ZD-P200A	Open Status	Raw Water Flow Control to DAF TNKP200A Valve Open	WP-P0002							DI	
1777	O	ZT-P200A	Position Feedback	Raw Water Flow Control to DAF TNKP200A Valve Position	WP-P0002							AI	
1778	O	MM-P201A	Running Status	DAF Flocculator FLC-P201A Running	WP-P0005							DI TCP	
1779	O	MN-P201A	Start Command	DAF Flocculator FLC-P201A Start	WP-P0005							DO TCP	
1780	O	SC-P201A	Speed Control Output	DAF Flocculator FLC-P201A Required Speed	WP-P0005							AO TCP	
1781	O	SI-P201A	Speed Indication	DAF Flocculator FLC-P201A Speed	WP-P0005							AI TCP	
1782	O	UF-P201A	No Fault	DAF Flocculator FLC-P201A Fault	WP-P0005							DI TCP	
1783	O	YS-P201A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P201A in Computer Mode	WP-P0005							DI TCP	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1784	O	MM-P202A	Running Status	DAF Flocculator FLC-P202A Running	WP-P0005							DI TCP	
1785	O	MN-P202A	Start Command	DAF Flocculator FLC-P202A Start	WP-P0005							DO TCP	
1786	O	SC-P202A	Speed Control Output	DAF Flocculator FLC-P202A Required Speed	WP-P0005							AO TCP	
1787	O	SI-P202A	Speed Indication	DAF Flocculator FLC-P202A Speed	WP-P0005							AI TCP	
1788	O	UF-P202A	No Fault	DAF Flocculator FLC-P202A Fault	WP-P0005							DI TCP	
1789	O	YS-P202A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P202A in Computer Mode	WP-P0005							DI TCP	
1790	O	MM-P203A	Running Status	DAF Flocculator FLC-P203A Running	WP-P0005							DI TCP	
1791	O	MN-P203A	Start Command	DAF Flocculator FLC-P203A Start	WP-P0005							DO TCP	
1792	O	SC-P203A	Speed Control Output	DAF Flocculator FLC-P203A Required Speed	WP-P0005							AO TCP	
1793	O	SI-P203A	Speed Indication	DAF Flocculator FLC-P203A Speed	WP-P0005							AI TCP	
1794	O	UF-P203A	No Fault	DAF Flocculator FLC-P203A Fault	WP-P0005							DI TCP	
1795	O	YS-P203A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P203A in Computer Mode	WP-P0005							DI TCP	
1796	O	MM-P204A	Running Status	DAF Flocculator FLC-P204A Running	WP-P0005							DI TCP	
1797	O	MN-P204A	Start Command	DAF Flocculator FLC-P204A Start	WP-P0005							DO TCP	
1798	O	SC-P204A	Speed Control Output	DAF Flocculator FLC-P204A Required Speed	WP-P0005							AO TCP	
1799	O	SI-P204A	Speed Indication	DAF Flocculator FLC-P204A Speed	WP-P0005							AI TCP	
1800	O	UF-P204A	No Fault	DAF Flocculator FLC-P204A Fault	WP-P0005							DI TCP	
1801	O	YS-P204A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P204A in Computer Mode	WP-P0005							DI TCP	
1802	O	MM-P205A	Running Status	DAF Flocculator FLC-P205A Running	WP-P0005							DI TCP	
1803	O	MN-P205A	Start Command	DAF Flocculator FLC-P205A Start	WP-P0005							DO TCP	
1804	O	SC-P205A	Speed Control Output	DAF Flocculator FLC-P205A Required Speed	WP-P0005							AO TCP	
1805	O	SI-P205A	Speed Indication	DAF Flocculator FLC-P205A Speed	WP-P0005							AI TCP	
1806	O	UF-P205A	No Fault	DAF Flocculator FLC-P205A Fault	WP-P0005							DI TCP	
1807	O	YS-P205A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P205A in Computer Mode	WP-P0005							DI TCP	
1808	O	MM-P206A	Running Status	DAF Flocculator FLC-P206A Running	WP-P0005							DI TCP	
1809	O	MN-P206A	Start Command	DAF Flocculator FLC-P206A Start	WP-P0005							DO TCP	
1810	O	SC-P206A	Speed Control Output	DAF Flocculator FLC-P206A Required Speed	WP-P0005							AO TCP	
1811	O	SI-P206A	Speed Indication	DAF Flocculator FLC-P206A Speed	WP-P0005							AI TCP	
1812	O	UF-P206A	No Fault	DAF Flocculator FLC-P206A Fault	WP-P0005							DI TCP	
1813	O	YS-P206A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P206A in Computer Mode	WP-P0005							DI TCP	
1814	O	YS-P210A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P200A Valve in Computer Mode	WP-P0005							DI	
1815	O	YS-P210B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P200A Valve in Computer Mode	WP-P0005							DI	
1816	O	ZB-P210A	Closed Status	Air Saturated Water to DAF TNK-P200A Valve Closed	WP-P0005							DI	
1817	O	ZC-P210A	Position Control Output	Air Saturated Water to DAF TNK-P200A Valve Required Position	WP-P0005							AO	
1818	O	ZD-P210A	Open Status	Air Saturated Water to DAF TNK-P200A Valve Open	WP-P0005							DI	
1819	O	ZT-P210A	Position Feedback	Air Saturated Water to DAF TNK-P200A Valve Position	WP-P0005							AI	
1820	O	ZB-P210B	Closed Status	Air Saturated Water to DAF TNK-P200A Valve Closed	WP-P0005							DI	
1821	O	ZC-P210B	Position Control Output	Air Saturated Water to DAF TNK-P200A Valve Required Position	WP-P0005							AO	
1822	O	ZD-P210B	Open Status	Air Saturated Water to DAF TNK-P200A Valve Open	WP-P0005							DI	
1823	O	ZT-P210B	Position Feedback	Air Saturated Water to DAF TNK-P200A Valve Position	WP-P0005							AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1824	O	YD-P220A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP200A) Open	WP-P0005							DO	
1825	O	YD-P220B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP200A) Open	WP-P0005							DO	
1826	O	YS-P240A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP200A) in Computer Mode	WP-P0005							DI	
1827	O	ZB-P240A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP200A) Closed	WP-P0005							DI	
1828	O	ZC-P240A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP200A) Required Position	WP-P0005							AO	
1829	O	ZD-P240A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP200A) Open	WP-P0005							DI	
1830	O	ZT-P240A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP200A) Position	WP-P0005							AI	
1831	O	FI-P300A	Flow Indication	Raw Water Flow Rate to DAF TNKP300A	WP-P0002							AI	
1832	O	FQ-P300A	Flow Pulse	Raw Water Flow Total to DAF TNKP300A	WP-P0002							DI	
1833	O	LF-P300A	No Fault	DAF TNKP300A Level Fault	WP-P0006							DI	
1834	O	LI-P300A	Level Indication	DAF TNKP300A Level	WP-P0006							AI	
1835	O	MF-P300A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P300A Travelled Reverse	WP-P0006							DI TCP	
1836	O	MM-P300A	Running Status	DAF Float Reciprocating Scraper FLC-P300A Running	WP-P0006							DI TCP	
1837	O	MN-P300A	Start Command	DAF Float Reciprocating Scraper FLC-P300A Start	WP-P0006							DO TCP	
1838	O	MR-P300A	Forward Limit	DAF Float Reciprocating Scraper FLC-P300A Travelled Forward	WP-P0006							DI TCP	
1839	O	SC-P300A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P300A Required Speed	WP-P0006							AO TCP	
1840	O	SI-P300A	Speed Indication	DAF Float Reciprocating Scraper FLC-P300A Speed	WP-P0006							AI TCP	
1841	O	UF-P300A	No Fault	DAF Float Reciprocating Scraper FLC-P300A Fault	WP-P0006							DI TCP	
1842	O	YS-P300A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP300A Valve in Computer Mode	WP-P0002							DI	
1843	O	YS-P300A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P300A in Computer Mode	WP-P0006							DI TCP	
1844	O	ZB-P300A	Closed Status	Raw Water Flow Control to DAF TNKP300A Valve Closed	WP-P0002							DI	
1845	O	ZC-P300A	Position Control Output	Raw Water Flow Control to DAF TNKP300A Valve Required Position	WP-P0002							AO	
1846	O	ZD-P300A	Open Status	Raw Water Flow Control to DAF TNKP300A Valve Open	WP-P0002							DI	
1847	O	ZT-P300A	Position Feedback	Raw Water Flow Control to DAF TNKP300A Valve Position	WP-P0002							AI	
1848	O	MM-P301A	Running Status	DAF Flocculator FLC-P301A Running	WP-P0006							DI TCP	
1849	O	MN-P301A	Start Command	DAF Flocculator FLC-P301A Start	WP-P0006							DO TCP	
1850	O	SC-P301A	Speed Control Output	DAF Flocculator FLC-P301A Required Speed	WP-P0006							AO TCP	
1851	O	SI-P301A	Speed Indication	DAF Flocculator FLC-P301A Speed	WP-P0006							AI TCP	
1852	O	UF-P301A	No Fault	DAF Flocculator FLC-P301A Fault	WP-P0006							DI TCP	
1853	O	YS-P301A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P301A in Computer Mode	WP-P0006							DI TCP	
1854	O	MM-P302A	Running Status	DAF Flocculator FLC-P302A Running	WP-P0006							DI TCP	
1855	O	MN-P302A	Start Command	DAF Flocculator FLC-P302A Start	WP-P0006							DO TCP	
1856	O	SC-P302A	Speed Control Output	DAF Flocculator FLC-P302A Required Speed	WP-P0006							AO TCP	
1857	O	SI-P302A	Speed Indication	DAF Flocculator FLC-P302A Speed	WP-P0006							AI TCP	
1858	O	UF-P302A	No Fault	DAF Flocculator FLC-P302A Fault	WP-P0006							DI TCP	
1859	O	YS-P302A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P302A in Computer Mode	WP-P0006							DI TCP	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1860	O	MM-P303A	Running Status	DAF Flocculator FLC-P303A Running	WP-P0006							DI TCP	
1861	O	MN-P303A	Start Command	DAF Flocculator FLC-P303A Start	WP-P0006							DO TCP	
1862	O	SC-P303A	Speed Control Output	DAF Flocculator FLC-P303A Required Speed	WP-P0006							AO TCP	
1863	O	SI-P303A	Speed Indication	DAF Flocculator FLC-P303A Speed	WP-P0006							AI TCP	
1864	O	UF-P303A	No Fault	DAF Flocculator FLC-P303A Fault	WP-P0006							DI TCP	
1865	O	YS-P303A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P303A in Computer Mode	WP-P0006							DI TCP	
1866	O	MM-P304A	Running Status	DAF Flocculator FLC-P304A Running	WP-P0006							DI TCP	
1867	O	MN-P304A	Start Command	DAF Flocculator FLC-P304A Start	WP-P0006							DO TCP	
1868	O	SC-P304A	Speed Control Output	DAF Flocculator FLC-P304A Required Speed	WP-P0006							AO TCP	
1869	O	SI-P304A	Speed Indication	DAF Flocculator FLC-P304A Speed	WP-P0006							AI TCP	
1870	O	UF-P304A	No Fault	DAF Flocculator FLC-P304A Fault	WP-P0006							DI TCP	
1871	O	YS-P304A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P304A in Computer Mode	WP-P0006							DI TCP	
1872	O	MM-P305A	Running Status	DAF Flocculator FLC-P305A Running	WP-P0006							DI TCP	
1873	O	MN-P305A	Start Command	DAF Flocculator FLC-P305A Start	WP-P0006							DO TCP	
1874	O	SC-P305A	Speed Control Output	DAF Flocculator FLC-P305A Required Speed	WP-P0006							AO TCP	
1875	O	SI-P305A	Speed Indication	DAF Flocculator FLC-P305A Speed	WP-P0006							AI TCP	
1876	O	UF-P305A	No Fault	DAF Flocculator FLC-P305A Fault	WP-P0006							DI TCP	
1877	O	YS-P305A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P305A in Computer Mode	WP-P0006							DI TCP	
1878	O	MM-P306A	Running Status	DAF Flocculator FLC-P306A Running	WP-P0006							DI TCP	
1879	O	MN-P306A	Start Command	DAF Flocculator FLC-P306A Start	WP-P0006							DO TCP	
1880	O	SC-P306A	Speed Control Output	DAF Flocculator FLC-P306A Required Speed	WP-P0006							AO TCP	
1881	O	SI-P306A	Speed Indication	DAF Flocculator FLC-P306A Speed	WP-P0006							AI TCP	
1882	O	UF-P306A	No Fault	DAF Flocculator FLC-P306A Fault	WP-P0006							DI TCP	
1883	O	YS-P306A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P306A in Computer Mode	WP-P0006							DI TCP	
1884	O	YS-P310A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P300A Valve in Computer Mode	WP-P0006							DI	
1885	O	YS-P310B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P300A Valve in Computer Mode	WP-P0006							DI	
1886	O	ZB-P310A	Closed Status	Air Saturated Water to DAF TNK-P300A Valve Closed	WP-P0006							DI	
1887	O	ZC-P310A	Position Control Output	Air Saturated Water to DAF TNK-P300A Valve Required Position	WP-P0006							AO	
1888	O	ZD-P310A	Open Status	Air Saturated Water to DAF TNK-P300A Valve Open	WP-P0006							DI	
1889	O	ZT-P310A	Position Feedback	Air Saturated Water to DAF TNK-P300A Valve Position	WP-P0006							AI	
1890	O	ZB-P310B	Closed Status	Air Saturated Water to DAF TNK-P300A Valve Closed	WP-P0006							DI	
1891	O	ZC-P310B	Position Control Output	Air Saturated Water to DAF TNK-P300A Valve Required Position	WP-P0006							AO	
1892	O	ZD-P310B	Open Status	Air Saturated Water to DAF TNK-P300A Valve Open	WP-P0006							DI	
1893	O	ZT-P310B	Position Feedback	Air Saturated Water to DAF TNK-P300A Valve Position	WP-P0006							AI	
1894	O	YD-P320A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP300A) Open	WP-P0006							DO	
1895	O	YD-P320B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP300A) Open	WP-P0006							DO	
1896	O	YS-P340A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP300A) in Computer Mode	WP-P0006							DI	
1897	O	ZB-P340A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP300A) Closed	WP-P0006							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1898	O	ZC-P340A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP300A) Required Position	WP-P0006							AO	
1899	O	ZD-P340A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP300A) Open	WP-P0006							DI	
1900	O	ZT-P340A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP300A) Position	WP-P0006							AI	
1901	O	FI-P400A	Flow Indication	Raw Water Flow Rate to DAF TNKP400A	WP-P0002							AI	
1902	O	FQ-P400A	Flow Pulse	Raw Water Flow Total to DAF TNKP400A	WP-P0002							DI	
1903	O	LF-P400A	No Fault	DAF TNKP400A Level Fault	WP-P0007							DI	
1904	O	LI-P400A	Level Indication	DAF TNKP400A Level	WP-P0007							AI	
1905	O	MF-P400A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P400A Travelled Reverse	WP-P0007							DI TCP	
1906	O	MM-P400A	Running Status	DAF Float Reciprocating Scraper FLC-P400A Running	WP-P0007							DI TCP	
1907	O	MN-P400A	Start Command	DAF Float Reciprocating Scraper FLC-P400A Start	WP-P0007							DO TCP	
1908	O	MR-P400A	Forward Limit	DAF Float Reciprocating Scraper FLC-P400A Travelled Forward	WP-P0007							DI TCP	
1909	O	SC-P400A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P400A Required Speed	WP-P0007							AO TCP	
1910	O	SI-P400A	Speed Indication	DAF Float Reciprocating Scraper FLC-P400A Speed	WP-P0007							AI TCP	
1911	O	UF-P400A	No Fault	DAF Float Reciprocating Scraper FLC-P400A Fault	WP-P0007							DI TCP	
1912	O	YS-P400A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP400A Valve in Computer Mode	WP-P0002							DI	
1913	O	YS-P400A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P400A in Computer Mode	WP-P0007							DI TCP	
1914	O	ZB-P400A	Closed Status	Raw Water Flow Control to DAF TNKP400A Valve Closed	WP-P0002							DI	
1915	O	ZC-P400A	Position Control Output	Raw Water Flow Control to DAF TNKP400A Valve Required Position	WP-P0002							AO	
1916	O	ZD-P400A	Open Status	Raw Water Flow Control to DAF TNKP400A Valve Open	WP-P0002							DI	
1917	O	ZT-P400A	Position Feedback	Raw Water Flow Control to DAF TNKP400A Valve Position	WP-P0002							AI	
1918	O	MM-P401A	Running Status	DAF Flocculator FLC-P401A Running	WP-P0007							DI TCP	
1919	O	MN-P401A	Start Command	DAF Flocculator FLC-P401A Start	WP-P0007							DO TCP	
1920	O	SC-P401A	Speed Control Output	DAF Flocculator FLC-P401A Required Speed	WP-P0007							AO TCP	
1921	O	SI-P401A	Speed Indication	DAF Flocculator FLC-P401A Speed	WP-P0007							AI TCP	
1922	O	UF-P401A	No Fault	DAF Flocculator FLC-P401A Fault	WP-P0007							DI TCP	
1923	O	YS-P401A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P401A in Computer Mode	WP-P0007							DI TCP	
1924	O	MM-P402A	Running Status	DAF Flocculator FLC-P402A Running	WP-P0007							DI TCP	
1925	O	MN-P402A	Start Command	DAF Flocculator FLC-P402A Start	WP-P0007							DO TCP	
1926	O	SC-P402A	Speed Control Output	DAF Flocculator FLC-P402A Required Speed	WP-P0007							AO TCP	
1927	O	SI-P402A	Speed Indication	DAF Flocculator FLC-P402A Speed	WP-P0007							AI TCP	
1928	O	UF-P402A	No Fault	DAF Flocculator FLC-P402A Fault	WP-P0007							DI TCP	
1929	O	YS-P402A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P402A in Computer Mode	WP-P0007							DI TCP	
1930	O	MM-P403A	Running Status	DAF Flocculator FLC-P403A Running	WP-P0007							DI TCP	
1931	O	MN-P403A	Start Command	DAF Flocculator FLC-P403A Start	WP-P0007							DO TCP	
1932	O	SC-P403A	Speed Control Output	DAF Flocculator FLC-P403A Required Speed	WP-P0007							AO TCP	
1933	O	SI-P403A	Speed Indication	DAF Flocculator FLC-P403A Speed	WP-P0007							AI TCP	
1934	O	UF-P403A	No Fault	DAF Flocculator FLC-P403A Fault	WP-P0007							DI TCP	
1935	O	YS-P403A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P403A in Computer Mode	WP-P0007							DI TCP	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1936	O	MM-P404A	Running Status	DAF Flocculator FLC-P404A Running	WP-P0007							DI TCP	
1937	O	MN-P404A	Start Command	DAF Flocculator FLC-P404A Start	WP-P0007							DO TCP	
1938	O	SC-P404A	Speed Control Output	DAF Flocculator FLC-P404A Required Speed	WP-P0007							AO TCP	
1939	O	SI-P404A	Speed Indication	DAF Flocculator FLC-P404A Speed	WP-P0007							AI TCP	
1940	O	UF-P404A	No Fault	DAF Flocculator FLC-P404A Fault	WP-P0007							DI TCP	
1941	O	YS-P404A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P404A in Computer Mode	WP-P0007							DI TCP	
1942	O	MM-P405A	Running Status	DAF Flocculator FLC-P405A Running	WP-P0007							DI TCP	
1943	O	MN-P405A	Start Command	DAF Flocculator FLC-P405A Start	WP-P0007							DO TCP	
1944	O	SC-P405A	Speed Control Output	DAF Flocculator FLC-P405A Required Speed	WP-P0007							AO TCP	
1945	O	SI-P405A	Speed Indication	DAF Flocculator FLC-P405A Speed	WP-P0007							AI TCP	
1946	O	UF-P405A	No Fault	DAF Flocculator FLC-P405A Fault	WP-P0007							DI TCP	
1947	O	YS-P405A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P405A in Computer Mode	WP-P0007							DI TCP	
1948	O	MM-P406A	Running Status	DAF Flocculator FLC-P406A Running	WP-P0007							DI TCP	
1949	O	MN-P406A	Start Command	DAF Flocculator FLC-P406A Start	WP-P0007							DO TCP	
1950	O	SC-P406A	Speed Control Output	DAF Flocculator FLC-P406A Required Speed	WP-P0007							AO TCP	
1951	O	SI-P406A	Speed Indication	DAF Flocculator FLC-P406A Speed	WP-P0007							AI TCP	
1952	O	UF-P406A	No Fault	DAF Flocculator FLC-P406A Fault	WP-P0007							DI TCP	
1953	O	YS-P406A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P406A in Computer Mode	WP-P0007							DI TCP	
1954	O	YS-P410A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P400A Valve in Computer Mode	WP-P0007							DI	
1955	O	YS-P410B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P400A Valve in Computer Mode	WP-P0007							DI	
1956	O	ZB-P410A	Closed Status	Air Saturated Water to DAF TNK-P400A Valve Closed	WP-P0007							DI	
1957	O	ZC-P410A	Position Control Output	Air Saturated Water to DAF TNK-P400A Valve Required Position	WP-P0007							AO	
1958	O	ZD-P410A	Open Status	Air Saturated Water to DAF TNK-P400A Valve Open	WP-P0007							DI	
1959	O	ZT-P410A	Position Feedback	Air Saturated Water to DAF TNK-P400A Valve Position	WP-P0007							AI	
1960	O	ZB-P410B	Closed Status	Air Saturated Water to DAF TNK-P400A Valve Closed	WP-P0007							DI	
1961	O	ZC-P410B	Position Control Output	Air Saturated Water to DAF TNK-P400A Valve Required Position	WP-P0007							AO	
1962	O	ZD-P410B	Open Status	Air Saturated Water to DAF TNK-P400A Valve Open	WP-P0007							DI	
1963	O	ZT-P410B	Position Feedback	Air Saturated Water to DAF TNK-P400A Valve Position	WP-P0007							AI	
1964	O	YD-P420A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP400A) Open	WP-P0007							DO	
1965	O	YD-P420B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP400A) Open	WP-P0007							DO	
1966	O	YS-P440A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP400A) in Computer Mode	WP-P0007							DI	
1967	O	ZB-P440A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP400A) Closed	WP-P0007							DI	
1968	O	ZC-P440A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP400A) Required Position	WP-P0007							AO	
1969	O	ZD-P440A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP400A) Open	WP-P0007							DI	
1970	O	ZT-P440A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP400A) Position	WP-P0007							AI	
1971	O	FI-P500A	Flow Indication	Raw Water Flow Rate to DAF TNKP500A	WP-P0003							AI	
1972	O	FQ-P500A	Flow Pulse	Raw Water Flow Total to DAF TNKP500A	WP-P0003							DI	
1973	O	LF-P500A	No Fault	DAF TNKP500A Level Fault	WP-P0008							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
1974	O	LI-P500A	Level Indication	DAF TNKP500A Level	WP-P0008							AI	
1975	O	MF-P500A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P500A Travelled Reverse	WP-P0008							DI TCP	
1976	O	MM-P500A	Running Status	DAF Float Reciprocating Scraper FLC-P500A Running	WP-P0008							DI TCP	
1977	O	MN-P500A	Start Command	DAF Float Reciprocating Scraper FLC-P500A Start	WP-P0008							DO TCP	
1978	O	MR-P500A	Forward Limit	DAF Float Reciprocating Scraper FLC-P500A Travelled Forward	WP-P0008							DI TCP	
1979	O	SC-P500A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P500A Required Speed	WP-P0008							AO TCP	
1980	O	SI-P500A	Speed Indication	DAF Float Reciprocating Scraper FLC-P500A Speed	WP-P0008							AI TCP	
1981	O	UF-P500A	No Fault	DAF Float Reciprocating Scraper FLC-P500A Fault	WP-P0008							DI TCP	
1982	O	YS-P500A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP500A Valve in Computer Mode	WP-P0003							DI	
1983	O	YS-P500A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P500A in Computer Mode	WP-P0008							DI TCP	
1984	O	ZB-P500A	Closed Status	Raw Water Flow Control to DAF TNKP500A Valve Closed	WP-P0003							DI	
1985	O	ZC-P500A	Position Control Output	Raw Water Flow Control to DAF TNKP500A Valve Required Position	WP-P0003							AO	
1986	O	ZD-P500A	Open Status	Raw Water Flow Control to DAF TNKP500A Valve Open	WP-P0003							DI	
1987	O	ZT-P500A	Position Feedback	Raw Water Flow Control to DAF TNKP500A Valve Position	WP-P0003							AI	
1988	O	MM-P501A	Running Status	DAF Flocculator FLC-P501A Running	WP-P0008							DI TCP	
1989	O	MN-P501A	Start Command	DAF Flocculator FLC-P501A Start	WP-P0008							DO TCP	
1990	O	SC-P501A	Speed Control Output	DAF Flocculator FLC-P501A Required Speed	WP-P0008							AO TCP	
1991	O	SI-P501A	Speed Indication	DAF Flocculator FLC-P501A Speed	WP-P0008							AI TCP	
1992	O	UF-P501A	No Fault	DAF Flocculator FLC-P501A Fault	WP-P0008							DI TCP	
1993	O	YS-P501A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P501A in Computer Mode	WP-P0008							DI TCP	
1994	O	MM-P502A	Running Status	DAF Flocculator FLC-P502A Running	WP-P0008							DI TCP	
1995	O	MN-P502A	Start Command	DAF Flocculator FLC-P502A Start	WP-P0008							DO TCP	
1996	O	SC-P502A	Speed Control Output	DAF Flocculator FLC-P502A Required Speed	WP-P0008							AO TCP	
1997	O	SI-P502A	Speed Indication	DAF Flocculator FLC-P502A Speed	WP-P0008							AI TCP	
1998	O	UF-P502A	No Fault	DAF Flocculator FLC-P502A Fault	WP-P0008							DI TCP	
1999	O	YS-P502A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P502A in Computer Mode	WP-P0008							DI TCP	
2000	O	MM-P503A	Running Status	DAF Flocculator FLC-P503A Running	WP-P0008							DI TCP	
2001	O	MN-P503A	Start Command	DAF Flocculator FLC-P503A Start	WP-P0008							DO TCP	
2002	O	SC-P503A	Speed Control Output	DAF Flocculator FLC-P503A Required Speed	WP-P0008							AO TCP	
2003	O	SI-P503A	Speed Indication	DAF Flocculator FLC-P503A Speed	WP-P0008							AI TCP	
2004	O	UF-P503A	No Fault	DAF Flocculator FLC-P503A Fault	WP-P0008							DI TCP	
2005	O	YS-P503A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P503A in Computer Mode	WP-P0008							DI TCP	
2006	O	MM-P504A	Running Status	DAF Flocculator FLC-P504A Running	WP-P0008							DI TCP	
2007	O	MN-P504A	Start Command	DAF Flocculator FLC-P504A Start	WP-P0008							DO TCP	
2008	O	SC-P504A	Speed Control Output	DAF Flocculator FLC-P504A Required Speed	WP-P0008							AO TCP	
2009	O	SI-P504A	Speed Indication	DAF Flocculator FLC-P504A Speed	WP-P0008							AI TCP	
2010	O	UF-P504A	No Fault	DAF Flocculator FLC-P504A Fault	WP-P0008							DI TCP	
2011	O	YS-P504A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P504A in Computer Mode	WP-P0008							DI TCP	
2012	O	MM-P505A	Running Status	DAF Flocculator FLC-P505A Running	WP-P0008							DI TCP	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2013	O	MN-P505A	Start Command	DAF Flocculator FLC-P505A Start	WP-P0008							DO TCP	
2014	O	SC-P505A	Speed Control Output	DAF Flocculator FLC-P505A Required Speed	WP-P0008							AO TCP	
2015	O	SI-P505A	Speed Indication	DAF Flocculator FLC-P505A Speed	WP-P0008							AI TCP	
2016	O	UF-P505A	No Fault	DAF Flocculator FLC-P505A Fault	WP-P0008							DI TCP	
2017	O	YS-P505A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P505A in Computer Mode	WP-P0008							DI TCP	
2018	O	MM-P506A	Running Status	DAF Flocculator FLC-P506A Running	WP-P0008							DI TCP	
2019	O	MN-P506A	Start Command	DAF Flocculator FLC-P506A Start	WP-P0008							DO TCP	
2020	O	SC-P506A	Speed Control Output	DAF Flocculator FLC-P506A Required Speed	WP-P0008							AO TCP	
2021	O	SI-P506A	Speed Indication	DAF Flocculator FLC-P506A Speed	WP-P0008							AI TCP	
2022	O	UF-P506A	No Fault	DAF Flocculator FLC-P506A Fault	WP-P0008							DI TCP	
2023	O	YS-P506A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P506A in Computer Mode	WP-P0008							DI TCP	
2024	O	YS-P510A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P500A Valve in Computer Mode	WP-P0008							DI	
2025	O	YS-P510B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P500A Valve in Computer Mode	WP-P0008							DI	
2026	O	ZB-P510A	Closed Status	Air Saturated Water to DAF TNK-P500A Valve Closed	WP-P0008							DI	
2027	O	ZC-P510A	Position Control Output	Air Saturated Water to DAF TNK-P500A Valve Required Position	WP-P0008							AO	
2028	O	ZD-P510A	Open Status	Air Saturated Water to DAF TNK-P500A Valve Open	WP-P0008							DI	
2029	O	ZT-P510A	Position Feedback	Air Saturated Water to DAF TNK-P500A Valve Position	WP-P0008							AI	
2030	O	ZB-P510B	Closed Status	Air Saturated Water to DAF TNK-P500A Valve Closed	WP-P0008							DI	
2031	O	ZC-P510B	Position Control Output	Air Saturated Water to DAF TNK-P500A Valve Required Position	WP-P0008							AO	
2032	O	ZD-P510B	Open Status	Air Saturated Water to DAF TNK-P500A Valve Open	WP-P0008							DI	
2033	O	ZT-P510B	Position Feedback	Air Saturated Water to DAF TNK-P500A Valve Position	WP-P0008							AI	
2034	O	YD-P520A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP500A) Open	WP-P0008							DO	
2035	O	YD-P520B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP500A) Open	WP-P0008							DO	
2036	O	YS-P540A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP500A) in Computer Mode	WP-P0008							DI	
2037	O	ZB-P540A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP500A) Closed	WP-P0008							DI	
2038	O	ZC-P540A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP500A) Required Position	WP-P0008							AO	
2039	O	ZD-P540A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP500A) Open	WP-P0008							DI	
2040	O	ZT-P540A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP500A) Position	WP-P0008							AI	
2041	O	FI-P600A	Flow Indication	Raw Water Flow Rate to DAF TNKP600A	WP-P0003							AI	
2042	O	FQ-P600A	Flow Pulse	Raw Water Flow Total to DAF TNKP600A	WP-P0003							DI	
2043	O	LF-P600A	No Fault	DAF TNKP600A Level Fault	WP-P0009							DI	
2044	O	LI-P600A	Level Indication	DAF TNKP600A Level	WP-P0009							AI	
2045	O	MF-P600A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P600A Travelled Reverse	WP-P0009							DI TCP	
2046	O	MM-P600A	Running Status	DAF Float Reciprocating Scraper FLC-P600A Running	WP-P0009							DI TCP	
2047	O	MN-P600A	Start Command	DAF Float Reciprocating Scraper FLC-P600A Start	WP-P0009							DO TCP	
2048	O	MR-P600A	Forward Limit	DAF Float Reciprocating Scraper FLC-P600A Travelled Forward	WP-P0009							DI TCP	
2049	O	SC-P600A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P600A Required Speed	WP-P0009							AO TCP	
2050	O	SI-P600A	Speed Indication	DAF Float Reciprocating Scraper FLC-P600A Speed	WP-P0009							AI TCP	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2051	O	UF-P600A	No Fault	DAF Float Reciprocating Scraper FLC-P600A Fault	WP-P0009							DI TCP	
2052	O	YS-P600A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP600A Valve in Computer Mode	WP-P0003							DI	
2053	O	YS-P600A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P600A in Computer Mode	WP-P0009							DI TCP	
2054	O	ZB-P600A	Closed Status	Raw Water Flow Control to DAF TNKP600A Valve Closed	WP-P0003							DI	
2055	O	ZC-P600A	Position Control Output	Raw Water Flow Control to DAF TNKP600A Valve Required Position	WP-P0003							AO	
2056	O	ZD-P600A	Open Status	Raw Water Flow Control to DAF TNKP600A Valve Open	WP-P0003							DI	
2057	O	ZT-P600A	Position Feedback	Raw Water Flow Control to DAF TNKP600A Valve Position	WP-P0003							AI	
2058	O	MM-P601A	Running Status	DAF Flocculator FLC-P601A Running	WP-P0009							DI TCP	
2059	O	MN-P601A	Start Command	DAF Flocculator FLC-P601A Start	WP-P0009							DO TCP	
2060	O	SC-P601A	Speed Control Output	DAF Flocculator FLC-P601A Required Speed	WP-P0009							AO TCP	
2061	O	SI-P601A	Speed Indication	DAF Flocculator FLC-P601A Speed	WP-P0009							AI TCP	
2062	O	UF-P601A	No Fault	DAF Flocculator FLC-P601A Fault	WP-P0009							DI TCP	
2063	O	YS-P601A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P601A in Computer Mode	WP-P0009							DI TCP	
2064	O	MM-P602A	Running Status	DAF Flocculator FLC-P602A Running	WP-P0009							DI TCP	
2065	O	MN-P602A	Start Command	DAF Flocculator FLC-P602A Start	WP-P0009							DO TCP	
2066	O	SC-P602A	Speed Control Output	DAF Flocculator FLC-P602A Required Speed	WP-P0009							AO TCP	
2067	O	SI-P602A	Speed Indication	DAF Flocculator FLC-P602A Speed	WP-P0009							AI TCP	
2068	O	UF-P602A	No Fault	DAF Flocculator FLC-P602A Fault	WP-P0009							DI TCP	
2069	O	YS-P602A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P602A in Computer Mode	WP-P0009							DI TCP	
2070	O	MM-P603A	Running Status	DAF Flocculator FLC-P603A Running	WP-P0009							DI TCP	
2071	O	MN-P603A	Start Command	DAF Flocculator FLC-P603A Start	WP-P0009							DO TCP	
2072	O	SC-P603A	Speed Control Output	DAF Flocculator FLC-P603A Required Speed	WP-P0009							AO TCP	
2073	O	SI-P603A	Speed Indication	DAF Flocculator FLC-P603A Speed	WP-P0009							AI TCP	
2074	O	UF-P603A	No Fault	DAF Flocculator FLC-P603A Fault	WP-P0009							DI TCP	
2075	O	YS-P603A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P603A in Computer Mode	WP-P0009							DI TCP	
2076	O	MM-P604A	Running Status	DAF Flocculator FLC-P604A Running	WP-P0009							DI TCP	
2077	O	MN-P604A	Start Command	DAF Flocculator FLC-P604A Start	WP-P0009							DO TCP	
2078	O	SC-P604A	Speed Control Output	DAF Flocculator FLC-P604A Required Speed	WP-P0009							AO TCP	
2079	O	SI-P604A	Speed Indication	DAF Flocculator FLC-P604A Speed	WP-P0009							AI TCP	
2080	O	UF-P604A	No Fault	DAF Flocculator FLC-P604A Fault	WP-P0009							DI TCP	
2081	O	YS-P604A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P604A in Computer Mode	WP-P0009							DI TCP	
2082	O	MM-P605A	Running Status	DAF Flocculator FLC-P605A Running	WP-P0009							DI TCP	
2083	O	MN-P605A	Start Command	DAF Flocculator FLC-P605A Start	WP-P0009							DO TCP	
2084	O	SC-P605A	Speed Control Output	DAF Flocculator FLC-P605A Required Speed	WP-P0009							AO TCP	
2085	O	SI-P605A	Speed Indication	DAF Flocculator FLC-P605A Speed	WP-P0009							AI TCP	
2086	O	UF-P605A	No Fault	DAF Flocculator FLC-P605A Fault	WP-P0009							DI TCP	
2087	O	YS-P605A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P605A in Computer Mode	WP-P0009							DI TCP	
2088	O	MM-P606A	Running Status	DAF Flocculator FLC-P606A Running	WP-P0009							DI TCP	
2089	O	MN-P606A	Start Command	DAF Flocculator FLC-P606A Start	WP-P0009							DO TCP	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2090	O	SC-P606A	Speed Control Output	DAF Flocculator FLC-P606A Required Speed	WP-P0009							AO TCP	
2091	O	SI-P606A	Speed Indication	DAF Flocculator FLC-P606A Speed	WP-P0009							AI TCP	
2092	O	UF-P606A	No Fault	DAF Flocculator FLC-P606A Fault	WP-P0009							DI TCP	
2093	O	YS-P606A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P606A in Computer Mode	WP-P0009							DI TCP	
2094	O	YS-P610A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P600A Valve in Computer Mode	WP-P0009							DI	
2095	O	YS-P610B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P600A Valve in Computer Mode	WP-P0009							DI	
2096	O	ZB-P610A	Closed Status	Air Saturated Water to DAF TNK-P600A Valve Closed	WP-P0009							DI	
2097	O	ZC-P610A	Position Control Output	Air Saturated Water to DAF TNK-P600A Valve Required Position	WP-P0009							AO	
2098	O	ZD-P610A	Open Status	Air Saturated Water to DAF TNK-P600A Valve Open	WP-P0009							DI	
2099	O	ZT-P610A	Position Feedback	Air Saturated Water to DAF TNK-P600A Valve Position	WP-P0009							AI	
2100	O	ZB-P610B	Closed Status	Air Saturated Water to DAF TNK-P600A Valve Closed	WP-P0009							DI	
2101	O	ZC-P610B	Position Control Output	Air Saturated Water to DAF TNK-P600A Valve Required Position	WP-P0009							AO	
2102	O	ZD-P610B	Open Status	Air Saturated Water to DAF TNK-P600A Valve Open	WP-P0009							DI	
2103	O	ZT-P610B	Position Feedback	Air Saturated Water to DAF TNK-P600A Valve Position	WP-P0009							AI	
2104	O	YD-P620A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP600A) Open	WP-P0009							DO	
2105	O	YD-P620B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP600A) Open	WP-P0009							DO	
2106	O	YS-P640A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP600A) in Computer Mode	WP-P0009							DI	
2107	O	ZB-P640A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP600A) Closed	WP-P0009							DI	
2108	O	ZC-P640A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP600A) Required Position	WP-P0009							AO	
2109	O	ZD-P640A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP600A) Open	WP-P0009							DI	
2110	O	ZT-P640A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP600A) Position	WP-P0009							AI	
2111	O	FI-P700A	Flow Indication	Raw Water Flow Rate to DAF TNKP700A	WP-P0003							AI	
2112	O	FQ-P700A	Flow Pulse	Raw Water Flow Total to DAF TNKP700A	WP-P0003							DI	
2113	O	LF-P700A	No Fault	DAF TNKP700A Level Fault	WP-P0010							DI	
2114	O	LI-P700A	Level Indication	DAF TNKP700A Level	WP-P0010							AI	
2115	O	MF-P700A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P700A Travelled Reverse	WP-P0010							DI TCP	
2116	O	MM-P700A	Running Status	DAF Float Reciprocating Scraper FLC-P700A Running	WP-P0010							DI TCP	
2117	O	MN-P700A	Start Command	DAF Float Reciprocating Scraper FLC-P700A Start	WP-P0010							DO TCP	
2118	O	MR-P700A	Forward Limit	DAF Float Reciprocating Scraper FLC-P700A Travelled Forward	WP-P0010							DI TCP	
2119	O	SC-P700A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P700A Required Speed	WP-P0010							AO TCP	
2120	O	SI-P700A	Speed Indication	DAF Float Reciprocating Scraper FLC-P700A Speed	WP-P0010							AI TCP	
2121	O	UF-P700A	No Fault	DAF Float Reciprocating Scraper FLC-P700A Fault	WP-P0010							DI TCP	
2122	O	YS-P700A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP700A Valve in Computer Mode	WP-P0003							DI	
2123	O	YS-P700A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P700A in Computer Mode	WP-P0010							DI TCP	
2124	O	ZB-P700A	Closed Status	Raw Water Flow Control to DAF TNKP700A Valve Closed	WP-P0003							DI	
2125	O	ZC-P700A	Position Control Output	Raw Water Flow Control to DAF TNKP700A Valve Required Position	WP-P0003							AO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2126	O	ZD-P700A	Open Status	Raw Water Flow Control to DAF TNKP700A Valve Open	WP-P0003							DI	
2127	O	ZT-P700A	Position Feedback	Raw Water Flow Control to DAF TNKP700A Valve Position	WP-P0003							AI	
2128	O	MM-P701A	Running Status	DAF Flocculator FLC-P701A Running	WP-P0010							DI TCP	
2129	O	MN-P701A	Start Command	DAF Flocculator FLC-P701A Start	WP-P0010							DO TCP	
2130	O	SC-P701A	Speed Control Output	DAF Flocculator FLC-P701A Required Speed	WP-P0010							AO TCP	
2131	O	SI-P701A	Speed Indication	DAF Flocculator FLC-P701A Speed	WP-P0010							AI TCP	
2132	O	UF-P701A	No Fault	DAF Flocculator FLC-P701A Fault	WP-P0010							DI TCP	
2133	O	YS-P701A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P701A in Computer Mode	WP-P0010							DI TCP	
2134	O	MM-P702A	Running Status	DAF Flocculator FLC-P702A Running	WP-P0010							DI TCP	
2135	O	MN-P702A	Start Command	DAF Flocculator FLC-P702A Start	WP-P0010							DO TCP	
2136	O	SC-P702A	Speed Control Output	DAF Flocculator FLC-P702A Required Speed	WP-P0010							AO TCP	
2137	O	SI-P702A	Speed Indication	DAF Flocculator FLC-P702A Speed	WP-P0010							AI TCP	
2138	O	UF-P702A	No Fault	DAF Flocculator FLC-P702A Fault	WP-P0010							DI TCP	
2139	O	YS-P702A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P702A in Computer Mode	WP-P0010							DI TCP	
2140	O	MM-P703A	Running Status	DAF Flocculator FLC-P703A Running	WP-P0010							DI TCP	
2141	O	MN-P703A	Start Command	DAF Flocculator FLC-P703A Start	WP-P0010							DO TCP	
2142	O	SC-P703A	Speed Control Output	DAF Flocculator FLC-P703A Required Speed	WP-P0010							AO TCP	
2143	O	SI-P703A	Speed Indication	DAF Flocculator FLC-P703A Speed	WP-P0010							AI TCP	
2144	O	UF-P703A	No Fault	DAF Flocculator FLC-P703A Fault	WP-P0010							DI TCP	
2145	O	YS-P703A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P703A in Computer Mode	WP-P0010							DI TCP	
2146	O	MM-P704A	Running Status	DAF Flocculator FLC-P704A Running	WP-P0010							DI TCP	
2147	O	MN-P704A	Start Command	DAF Flocculator FLC-P704A Start	WP-P0010							DO TCP	
2148	O	SC-P704A	Speed Control Output	DAF Flocculator FLC-P704A Required Speed	WP-P0010							AO TCP	
2149	O	SI-P704A	Speed Indication	DAF Flocculator FLC-P704A Speed	WP-P0010							AI TCP	
2150	O	UF-P704A	No Fault	DAF Flocculator FLC-P704A Fault	WP-P0010							DI TCP	
2151	O	YS-P704A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P704A in Computer Mode	WP-P0010							DI TCP	
2152	O	MM-P705A	Running Status	DAF Flocculator FLC-P705A Running	WP-P0010							DI TCP	
2153	O	MN-P705A	Start Command	DAF Flocculator FLC-P705A Start	WP-P0010							DO TCP	
2154	O	SC-P705A	Speed Control Output	DAF Flocculator FLC-P705A Required Speed	WP-P0010							AO TCP	
2155	O	SI-P705A	Speed Indication	DAF Flocculator FLC-P705A Speed	WP-P0010							AI TCP	
2156	O	UF-P705A	No Fault	DAF Flocculator FLC-P705A Fault	WP-P0010							DI TCP	
2157	O	YS-P705A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P705A in Computer Mode	WP-P0010							DI TCP	
2158	O	MM-P706A	Running Status	DAF Flocculator FLC-P706A Running	WP-P0010							DI TCP	
2159	O	MN-P706A	Start Command	DAF Flocculator FLC-P706A Start	WP-P0010							DO TCP	
2160	O	SC-P706A	Speed Control Output	DAF Flocculator FLC-P706A Required Speed	WP-P0010							AO TCP	
2161	O	SI-P706A	Speed Indication	DAF Flocculator FLC-P706A Speed	WP-P0010							AI TCP	
2162	O	UF-P706A	No Fault	DAF Flocculator FLC-P706A Fault	WP-P0010							DI TCP	
2163	O	YS-P706A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P706A in Computer Mode	WP-P0010							DI TCP	
2164	O	YS-P710A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P700A Valve in Computer Mode	WP-P0010							DI	
2165	O	YS-P710B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P700A Valve in Computer Mode	WP-P0010							DI	
2166	O	ZB-P710A	Closed Status	Air Saturated Water to DAF TNK-P700A Valve Closed	WP-P0010							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2167	O	ZC-P710A	Position Control Output	Air Saturated Water to DAF TNK-P700A Valve Required Position	WP-P0010							AO	
2168	O	ZD-P710A	Open Status	Air Saturated Water to DAF TNK-P700A Valve Open	WP-P0010							DI	
2169	O	ZT-P710A	Position Feedback	Air Saturated Water to DAF TNK-P700A Valve Position	WP-P0010							AI	
2170	O	ZB-P710B	Closed Status	Air Saturated Water to DAF TNK-P700A Valve Closed	WP-P0010							DI	
2171	O	ZC-P710B	Position Control Output	Air Saturated Water to DAF TNK-P700A Valve Required Position	WP-P0010							AO	
2172	O	ZD-P710B	Open Status	Air Saturated Water to DAF TNK-P700A Valve Open	WP-P0010							DI	
2173	O	ZT-P710B	Position Feedback	Air Saturated Water to DAF TNK-P700A Valve Position	WP-P0010							AI	
2174	O	YD-P720A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP700A) Open	WP-P0010							DO	
2175	O	YD-P720B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP700A) Open	WP-P0010							DO	
2176	O	YS-P740A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP700A) in Computer Mode	WP-P0010							DI	
2177	O	ZB-P740A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP700A) Closed	WP-P0010							DI	
2178	O	ZC-P740A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP700A) Required Position	WP-P0010							AO	
2179	O	ZD-P740A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP700A) Open	WP-P0010							DI	
2180	O	ZT-P740A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP700A) Position	WP-P0010							AI	
2181	O	FI-P800A	Flow Indication	Raw Water Flow Rate to DAF TNKP800A	WP-P0003							AI	
2182	O	FQ-P800A	Flow Pulse	Raw Water Flow Total to DAF TNKP800A	WP-P0003							DI	
2183	O	LF-P800A	No Fault	DAF TNKP800A Level Fault	WP-P0011							DI	
2184	O	LI-P800A	Level Indication	DAF TNKP800A Level	WP-P0011							AI	
2185	O	MF-P800A	Reverse Limit	DAF Float Reciprocating Scraper FLC-P800A Travelled Reverse	WP-P0011							DI TCP	
2186	O	MM-P800A	Running Status	DAF Float Reciprocating Scraper FLC-P800A Running	WP-P0011							DI TCP	
2187	O	MN-P800A	Start Command	DAF Float Reciprocating Scraper FLC-P800A Start	WP-P0011							DO TCP	
2188	O	MR-P800A	Forward Limit	DAF Float Reciprocating Scraper FLC-P800A Travelled Forward	WP-P0011							DI TCP	
2189	O	SC-P800A	Speed Control Output	DAF Float Reciprocating Scraper FLC-P800A Required Speed	WP-P0011							AO TCP	
2190	O	SI-P800A	Speed Indication	DAF Float Reciprocating Scraper FLC-P800A Speed	WP-P0011							AI TCP	
2191	O	UF-P800A	No Fault	DAF Float Reciprocating Scraper FLC-P800A Fault	WP-P0011							DI TCP	
2192	O	YS-P800A	C/O/H Switch in Computer Position	Raw Water Flow Control to DAF TNKP800A Valve in Computer Mode	WP-P0003							DI	
2193	O	YS-P800A	C/O/H Switch in Computer Position	DAF Float Reciprocating Scraper FLC-P800A in Computer Mode	WP-P0011							DI TCP	
2194	O	ZB-P800A	Closed Status	Raw Water Flow Control to DAF TNKP800A Valve Closed	WP-P0003							DI	
2195	O	ZC-P800A	Position Control Output	Raw Water Flow Control to DAF TNKP800A Valve Required Position	WP-P0003							AO	
2196	O	ZD-P800A	Open Status	Raw Water Flow Control to DAF TNKP800A Valve Open	WP-P0003							DI	
2197	O	ZT-P800A	Position Feedback	Raw Water Flow Control to DAF TNKP800A Valve Position	WP-P0003							AI	
2198	O	MM-P801A	Running Status	DAF Flocculator FLC-P801A Running	WP-P0011							DI TCP	
2199	O	MN-P801A	Start Command	DAF Flocculator FLC-P801A Start	WP-P0011							DO TCP	
2200	O	SC-P801A	Speed Control Output	DAF Flocculator FLC-P801A Required Speed	WP-P0011							AO TCP	
2201	O	SI-P801A	Speed Indication	DAF Flocculator FLC-P801A Speed	WP-P0011							AI TCP	
2202	O	UF-P801A	No Fault	DAF Flocculator FLC-P801A Fault	WP-P0011							DI TCP	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2203	O	YS-P801A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P801A in Computer Mode	WP-P0011							DI TCP	
2204	O	MM-P802A	Running Status	DAF Flocculator FLC-P802A Running	WP-P0011							DI TCP	
2205	O	MN-P802A	Start Command	DAF Flocculator FLC-P802A Start	WP-P0011							DO TCP	
2206	O	SC-P802A	Speed Control Output	DAF Flocculator FLC-P802A Required Speed	WP-P0011							AO TCP	
2207	O	SI-P802A	Speed Indication	DAF Flocculator FLC-P802A Speed	WP-P0011							AI TCP	
2208	O	UF-P802A	No Fault	DAF Flocculator FLC-P802A Fault	WP-P0011							DI TCP	
2209	O	YS-P802A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P802A in Computer Mode	WP-P0011							DI TCP	
2210	O	MM-P803A	Running Status	DAF Flocculator FLC-P803A Running	WP-P0011							DI TCP	
2211	O	MN-P803A	Start Command	DAF Flocculator FLC-P803A Start	WP-P0011							DO TCP	
2212	O	SC-P803A	Speed Control Output	DAF Flocculator FLC-P803A Required Speed	WP-P0011							AO TCP	
2213	O	SI-P803A	Speed Indication	DAF Flocculator FLC-P803A Speed	WP-P0011							AI TCP	
2214	O	UF-P803A	No Fault	DAF Flocculator FLC-P803A Fault	WP-P0011							DI TCP	
2215	O	YS-P803A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P803A in Computer Mode	WP-P0011							DI TCP	
2216	O	MM-P804A	Running Status	DAF Flocculator FLC-P804A Running	WP-P0011							DI TCP	
2217	O	MN-P804A	Start Command	DAF Flocculator FLC-P804A Start	WP-P0011							DO TCP	
2218	O	SC-P804A	Speed Control Output	DAF Flocculator FLC-P804A Required Speed	WP-P0011							AO TCP	
2219	O	SI-P804A	Speed Indication	DAF Flocculator FLC-P804A Speed	WP-P0011							AI TCP	
2220	O	UF-P804A	No Fault	DAF Flocculator FLC-P804A Fault	WP-P0011							DI TCP	
2221	O	YS-P804A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P804A in Computer Mode	WP-P0011							DI TCP	
2222	O	MM-P805A	Running Status	DAF Flocculator FLC-P805A Running	WP-P0011							DI TCP	
2223	O	MN-P805A	Start Command	DAF Flocculator FLC-P805A Start	WP-P0011							DO TCP	
2224	O	SC-P805A	Speed Control Output	DAF Flocculator FLC-P805A Required Speed	WP-P0011							AO TCP	
2225	O	SI-P805A	Speed Indication	DAF Flocculator FLC-P805A Speed	WP-P0011							AI TCP	
2226	O	UF-P805A	No Fault	DAF Flocculator FLC-P805A Fault	WP-P0011							DI TCP	
2227	O	YS-P805A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P805A in Computer Mode	WP-P0011							DI TCP	
2228	O	MM-P806A	Running Status	DAF Flocculator FLC-P806A Running	WP-P0011							DI TCP	
2229	O	MN-P806A	Start Command	DAF Flocculator FLC-P806A Start	WP-P0011							DO TCP	
2230	O	SC-P806A	Speed Control Output	DAF Flocculator FLC-P806A Required Speed	WP-P0011							AO TCP	
2231	O	SI-P806A	Speed Indication	DAF Flocculator FLC-P806A Speed	WP-P0011							AI TCP	
2232	O	UF-P806A	No Fault	DAF Flocculator FLC-P806A Fault	WP-P0011							DI TCP	
2233	O	YS-P806A	C/O/H Switch in Computer Position	DAF Flocculator FLC-P806A in Computer Mode	WP-P0011							DI TCP	
2234	O	YS-P810A	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P800A Valve in Computer Mode	WP-P0011							DI	
2235	O	YS-P810B	C/O/H Switch in Computer Position	Air Saturated Water to DAF TNK-P800A Valve in Computer Mode	WP-P0011							DI	
2236	O	ZB-P810A	Closed Status	Air Saturated Water to DAF TNK-P800A Valve Closed	WP-P0011							DI	
2237	O	ZC-P810A	Position Control Output	Air Saturated Water to DAF TNK-P800A Valve Required Position	WP-P0011							AO	
2238	O	ZD-P810A	Open Status	Air Saturated Water to DAF TNK-P800A Valve Open	WP-P0011							DI	
2239	O	ZT-P810A	Position Feedback	Air Saturated Water to DAF TNK-P800A Valve Position	WP-P0011							AI	
2240	O	ZB-P810B	Closed Status	Air Saturated Water to DAF TNK-P800A Valve Closed	WP-P0011							DI	
2241	O	ZC-P810B	Position Control Output	Air Saturated Water to DAF TNK-P800A Valve Required Position	WP-P0011							AO	
2242	O	ZD-P810B	Open Status	Air Saturated Water to DAF TNK-P800A Valve Open	WP-P0011							DI	
2243	O	ZT-P810B	Position Feedback	Air Saturated Water to DAF TNK-P800A Valve Position	WP-P0011							AI	

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PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2244	O	YD-P820A	Solenoid Actuator Output	DAF Basin Headwall Spray Wash Header Valve (TNKP800A) Open	WP-P0011							DO	
2245	O	YD-P820B	Solenoid Actuator Output	DAF Basin Float Trough Spray Wash Valve (TNKP800A) Open	WP-P0011							DO	
2246	O	YS-P840A	C/O/H Switch in Computer Position	DAF Basin Effluent Weir Bypass Gate (TNKP800A) in Computer Mode	WP-P0011							DI	
2247	O	ZB-P840A	Closed Status	DAF Basin Effluent Weir Bypass Gate (TNKP800A) Closed	WP-P0011							DI	
2248	O	ZC-P840A	Position Control Output	DAF Basin Effluent Weir Bypass Gate (TNKP800A) Required Position	WP-P0011							AO	
2249	O	ZD-P840A	Open Status	DAF Basin Effluent Weir Bypass Gate (TNKP800A) Open	WP-P0011							DI	
2250	O	ZT-P840A	Position Feedback	DAF Basin Effluent Weir Bypass Gate (TNKP800A) Position	WP-P0011							AI	
2251	O	PI-P900A	Pressure Indication	DAF Air Receiver Pressure	WP-P0015							AI	
2252	O	MM-P910A	Running Status	DAF Air Compressor CMP-P910A Running	WP-P0015							DI	
2253	O	MN-P910A	Start Command	DAF Air Compressor CMP-P910A Start	WP-P0015							DO	
2254	O	UF-P910A	No Fault	DAF Air Compressor CMP-P910A Fault	WP-P0015							DI	
2255	O	MM-P920A	Running Status	DAF Air Compressor CMP-P920A Running	WP-P0015							DI	
2256	O	MN-P920A	Start Command	DAF Air Compressor CMP-P920A Start	WP-P0015							DO	
2257	O	UF-P920A	No Fault	DAF Air Compressor CMP-P920A Fault	WP-P0015							DI	
2258	O	LI-P930A	Level Indication	DAF Float Sump P930A Level	WP-P0018							AI	
2259	O	LI-P930B	Level Indication	DAF Float Sump P930A Level	WP-P0018							AI	
2260	O	MM-P931A	Running Status	DAF Float Sump Sludge Pump P-P931A Running	WP-P0018							DI	
2261	O	MN-P931A	Start Command	DAF Float Sump Sludge Pump P-P931A Start	WP-P0018							DO	
2262	O	UF-P931A	No Fault	DAF Float Sump Sludge Pump P-P931A Fault	WP-P0018							DI	
2263	O	YS-P931A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P931A in Computer Mode	WP-P0018							DI	
2264	O	ZB-P931E	Closed Status	DAF Float Transfer Pump P931A Discharge Valve Closed	WP-P0018							DI	
2265	O	ZD-P931E	Open Status	DAF Float Transfer Pump P931A Discharge Valve Open	WP-P0018							DI	
2266	O	MM-P932A	Running Status	DAF Float Sump Sludge Pump P-P932A Running	WP-P0018							DI	
2267	O	MN-P932A	Start Command	DAF Float Sump Sludge Pump P-P932A Start	WP-P0018							DO	
2268	O	UF-P932A	No Fault	DAF Float Sump Sludge Pump P-P932A Fault	WP-P0018							DI	
2269	O	YS-P932A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P932A in Computer Mode	WP-P0018							DI	
2270	O	ZB-P932E	Closed Status	DAF Float Transfer Pump P-P932A Discharge Valve Closed	WP-P0018							DI	
2271	O	ZD-P932E	Open Status	DAF Float Transfer Pump P-P932A Discharge Valve Open	WP-P0018							DI	
2272	O	LI-P940A	Level Indication	DAF Float Sump P940A Level	WP-P0018							AI	
2273	O	LI-P940B	Level Indication	DAF Float Sump P940A Level	WP-P0018							AI	
2274	O	MM-P941A	Running Status	DAF Float Sump Sludge Pump P-P941A Running	WP-P0018							DI	
2275	O	MN-P941A	Start Command	DAF Float Sump Sludge Pump P-P941A Start	WP-P0018							DO	
2276	O	UF-P941A	No Fault	DAF Float Sump Sludge Pump P-P941A Fault	WP-P0018							DI	
2277	O	YS-P941A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P941A in Computer Mode	WP-P0018							DI	
2278	O	ZB-P941E	Closed Status	DAF Float Transfer Pump P-P941A Discharge Valve Closed	WP-P0018							DI	
2279	O	ZD-P941E	Open Status	DAF Float Transfer Pump P-P941A Discharge Valve Open	WP-P0018							DI	
2280	O	MM-P942A	Running Status	DAF Float Sump Sludge Pump P-P942A Running	WP-P0018							DI	
2281	O	MN-P942A	Start Command	DAF Float Sump Sludge Pump P-P942A Start	WP-P0018							DO	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2282	O	MM-P942A	Running Status	DAF Float Sump Sludge Pump P-P962A Running	WP-P0019							DI	
2283	O	MN-P942A	Start Command	DAF Float Sump Sludge Pump P-P962A Start	WP-P0019							DO	
2284	O	UF-P942A	No Fault	DAF Float Sump Sludge Pump P-P942A Fault	WP-P0018							DI	
2285	O	UF-P942A	No Fault	DAF Float Sump Sludge Pump P-P962A Fault	WP-P0019							DI	
2286	O	YS-P942A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P942A in Computer Mode	WP-P0018							DI	
2287	O	YS-P942A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P962A in Computer Mode	WP-P0019							DI	
2288	O	ZB-P942A	Closed Status	DAF Float Transfer Pump P-P942A Discharge Valve Closed	WP-P0018							DI	
2289	O	ZD-P942A	Open Status	DAF Float Transfer Pump P-P942A Discharge Valve Open	WP-P0018							DI	
2290	O	ZB-P942A	Closed Status	DAF Float Transfer Pump P-P962A Discharge Valve Closed	WP-P0019							DI	
2291	O	ZD-P942A	Open Status	DAF Float Transfer Pump P-P962A Discharge Valve Open	WP-P0019							DI	
2292	O	LI-P950A	Level Indication	DAF Float Sump P950A Level	WP-P0019							AI	
2293	O	LI-P950B	Level Indication	DAF Float Sump P950A Level	WP-P0019							AI	
2294	O	MM-P951A	Running Status	DAF Float Sump Sludge Pump P-P951A Running	WP-P0019							DI	
2295	O	MN-P951A	Start Command	DAF Float Sump Sludge Pump P-P951A Start	WP-P0019							DO	
2296	O	UF-P951A	No Fault	DAF Float Sump Sludge Pump P-P951A Fault	WP-P0019							DI	
2297	O	YS-P951A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P951A in Computer Mode	WP-P0019							DI	
2298	O	ZB-P951E	Closed Status	DAF Float Transfer Pump P951A Discharge Valve Closed	WP-P0019							DI	
2299	O	ZD-P951E	Open Status	DAF Float Transfer Pump P951A Discharge Valve Open	WP-P0019							DI	
2300	O	MM-P952A	Running Status	DAF Float Sump Sludge Pump P-P952A Running	WP-P0019							DI	
2301	O	MN-P952A	Start Command	DAF Float Sump Sludge Pump P-P952A Start	WP-P0019							DO	
2302	O	UF-P952A	No Fault	DAF Float Sump Sludge Pump P-P952A Fault	WP-P0019							DI	
2303	O	YS-P952A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P952A in Computer Mode	WP-P0019							DI	
2304	O	ZB-P952E	Closed Status	DAF Float Transfer Pump P-P952A Discharge Valve Closed	WP-P0019							DI	
2305	O	ZD-P952E	Open Status	DAF Float Transfer Pump P-P952A Discharge Valve Open	WP-P0019							DI	
2306	O	LI-P960A	Level Indication	DAF Float Sump P960A Level	WP-P0019							AI	
2307	O	LI-P960B	Level Indication	DAF Float Sump P960A Level	WP-P0019							AI	
2308	O	MM-P961A	Running Status	DAF Float Sump Sludge Pump P-P961A Running	WP-P0019							DI	
2309	O	MN-P961A	Start Command	DAF Float Sump Sludge Pump P-P961A Start	WP-P0019							DO	
2310	O	UF-P961A	No Fault	DAF Float Sump Sludge Pump P-P961A Fault	WP-P0019							DI	
2311	O	YS-P961A	C/O/H Switch in Computer Position	DAF Float Sump Sludge Pump P-P961A in Computer Mode	WP-P0019							DI	
2312	O	ZB-P961E	Closed Status	DAF Float Transfer Pump P-P961A Discharge Valve Closed	WP-P0019							DI	
2313	O	ZD-P961E	Open Status	DAF Float Transfer Pump P-P961A Discharge Valve Open	WP-P0019							DI	
2314	O	LA-P970A	Level Alarm	DAF Effluent Channel West Side (Train 1) High High Level	WP-P0017							DI	
2315	O	LF-P970A	Level Fault	DAF Effluent Channel West Side (Train 1) Level Fault	WP-P0017							DI	
2316	O	LI-P970A	Level Indication	DAF Effluent Channel West Side (Train 1) Level	WP-P0017							AI	
2317	O	LA-P971A	Level Alarm	DAF Effluent Channel East Side (Train 2) High High Level	WP-P0017							DI	
2318	O	LA-P971A	Level Fault	DAF Effluent Channel East Side (Train 2) Level Fault	WP-P0017							DI	
2319	O	LI-P971A	Level Indication	DAF Effluent Channel East Side (Train 2) Level	WP-P0017							AI	
2320	O	AT-P975A	Turbidity Indication	DAF Common Effluent Channel Turbidity	WP-P0017							AI	
2321	O	FA-P975A	Flow Alarm	DAF Common Effluent Channel Turbidity Low Sample Flow	WP-P0017							DI	
2322	O	LF-P980A	Level Fault	DAF Area Process Sump Pump Level Fault	WP-P0020							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2323	O	LI-P980A	Level Indication	DAF Area Process Sump Pump Level	WP-P0020							AI	
2324	O	LF-P980B	Level Fault	DAF Area Process Sump Pump Level Fault	WP-P0020							DI	
2325	O	LI-P980B	Level Indication	DAF Area Process Sump Pump Level	WP-P0020							AI	
2326	O	MM-P981A	Running Status	DAF Area Process Sump Pump P-P981A Running	WP-P0020							DI	
2327	O	MN-P981A	Start Command	DAF Area Process Sump Pump P-P981A Start	WP-P0020							DO	
2328	O	UF-P981A	No Fault	DAF Area Process Sump Pump P-P981A Fault	WP-P0020							DI	
2329	O	YS-P981A	C/O/H Switch in Computer Position	DAF Area Process Sump Pump P-P981A in Computer Mode	WP-P0020							DI	
2330	O	MM-P982A	Running Status	DAF Area Process Sump Pump P-P982A Running	WP-P0020							DI	
2331	O	MN-P982A	Start Command	DAF Area Process Sump Pump P-P982A Start	WP-P0020							DO	
2332	O	UF-P982A	No Fault	DAF Area Process Sump Pump P-P982A Fault	WP-P0020							DI	
2333	O	YS-P982A	C/O/H Switch in Computer Position	DAF Area Process Sump Pump P-P982A in Computer Mode	WP-P0020							DI	
2334	O	MM-P983A	Running Status	DAF Area Process Sump Pump P-P983A Running	WP-P0020							DI	
2335	O	MN-P983A	Start Command	DAF Area Process Sump Pump P-P983A Start	WP-P0020							DO	
2336	O	UF-P983A	No Fault	DAF Area Process Sump Pump P-P983A Fault	WP-P0020							DI	
2337	O	YS-P983A	C/O/H Switch in Computer Position	DAF Area Process Sump Pump P-P983A in Computer Mode	WP-P0020							DI	
2338	O	FI-P990A	Flow Indication	Sump P930A and Sump P940A Float Flow Rate	WP-P0018							AI	
2339	O	FQ-P990A	Flow Pulse	Sump P930A and Sump P940A Float Flow Total	WP-P0018							DI	
2340	O	FI-P993A	Flow Indication	Sump P930A and Sump P940A Float Flow Rate	WP-P0019							AI	
2341	O	FQ-P993A	Flow Pulse	Sump P930A and Sump P940A Float Flow Total	WP-P0019							DI	
2342	O	AF-R001A	Suspended Solids Fault	Washwater Recovery Tanks Sludge to Flocculation Chamber Suspended Solids Monitor Fault	WR-P0006							ADI	
2343	O	AI-R001A	Suspended Solids Indication	Washwater Recovery Tanks Sludge to Flocculation Chamber Suspended Solids Monitor	WR-P0006							AI	
2344	O	FI-R001B	Flow Indication	Washwater Recovery Tanks Sludge to Flocculation Chamber Flow Rate	WR-P0006							AI	
2345	O	FQ-R001B	Flow Pulse	Washwater Recovery Tanks Sludge to Flocculation Chamber Flow Total	WR-P0006							DI	
2346	O	LA-R001A	Level Relay	Flocculation Chamber Low Level	WR-P0006							DI	
2347	O	LA-R001B	Level Relay	Flocculation Chamber High Level Relay	WR-P0006							DI	
2348	O	LA-R001C	Level Relay	Flocculation Chamber High High Level	WR-P0006							DI	
2349	O	MM-R001C	Running Status	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer Running	WR-P0006							DI	
2350	O	MM-R001C	Running Status	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump Running	WR-P0006							DI	
2351	O	MN-R001C	Start Command	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer Start	WR-P0006							DO	
2352	O	MN-R001C	Start Command	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump Start	WR-P0006							DO	
2353	O	SC-R001C	Speed Control Output	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer Speed	WR-P0006							AO	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2354	O	SI-R001C	Speed Indication	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer Required Speed	WR-P0006							AI	
2355	O	UF-R001C	No Fault	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer Fault	WR-P0006							DI	
2356	O	YS-R001C	C/O/H Switch in Computer Position	Washwater Recovery Tanks Sludge Flocculation Chamber Mixer in Computer Mode	WR-P0006							DI	
2357	O	YS-R001C	C/O/H Switch in Computer Position	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump in Computer Mode	WR-P0006							DI	
2358	O	AF-R010A	Suspended Solids Fault	Washwater Recovery Tank Supernatent Suspended Solids Monitor Fault	WR-P0006							DI	
2359	O	AI-R010A	Suspended Solids Indication	Washwater Recovery Tank Supernatent Suspended Solids	WR-P0006							AI	
2360	O	FA-R010A	Flow Alarm	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump Outlet Flow	WR-P0006							DI	
2361	O	LA-R010A	Level Alarm	Washwater Recovery Tank Inlet Channel High Level	WR-P0001							DI	
2362	O	LA-R010B	Level Alarm	Washwater Recovery Tank Inlet Channel Low Level	WR-P0001							DI	
2363	O	ZB-R010A	Closed Status	Washwater Recovery Tank Inlet Channel Sluice Gate Open	WR-P0001							DI	
2364	O	ZD-R010A	Open Status	Washwater Recovery Tank Inlet Channel Sluice Gate Closed	WR-P0001							DI	
2365	O	ZB-R010B	Closed Status	Washwater Recovery Tank Inlet Channel Sluice Gate Open	WR-P0001							DI	
2366	O	ZD-R010B	Open Status	Washwater Recovery Tank Inlet Channel Sluice Gate Closed	WR-P0001							DI	
2367	O	LA-R020A	Level Switch	Supernatent Pump Station Low Low Level	WR-P0007							DI	
2368	O	LF-R020A	Level Element	Supernatent Pump Station Level	WR-P0007							DI	
2369	O	LI-R020A	Level Indicator Transmitter	Supernatent Pump Station Level	WR-P0007							AI	
2370	O	LA-R020B	Level Switch	Supernatent Pump Station High High Level	WR-P0007							DI	
2371	O	LA-R020C	Level Alarm	Overflow Channel High Level	WR-P0007							DI	
2372	O	MM-R021A	Running Status	Supernatent Pump P-R021A Running	WR-P0007							DI	
2373	O	MN-R021A	Start Command	Supernatent Pump P-R021A Start	WR-P0007							DO	
2374	O	SI-R021A	Speed Indication	Supernatent Pump P-R021A Speed	WR-P0007							AI	
2375	O	TI-R021B	Temperature Indication	Supernatent Pump P-R021A Winding Temperature	WR-P0007							AI	
2376	O	TI-R021C	Temperature Indication	Supernatent Pump P-R021A Bottom Bearing Temperature	WR-P0007							AI	
2377	O	TI-R021D	Temperature Indication	Supernatent Pump P-R021A Top Bearing Temperature	WR-P0007							AI	
2378	O	UF-R021A	No Fault	Supernatent Pump P-R021A Running Fault	WR-P0007							DI	
2379	O	VI-R021A	Vibration Transmitter	Supernatent Pump P-R021A Vibration	WR-P0007							AI	
2380	O	YS-R021A	C/O/H Switch in Computer Position	Supernatent Pump P-R021A In Computer Mode	WR-P0007							DI	
2381	O	YS-R021A	C/O/H Switch in Computer Position	Supernatent Pump P-R021A Speed Control Actuator in Computer Mode	WR-P0007							DI	
2382	O	ZB-R021A	Closed Status	Supernatent Pump P-R021A Outlet Manual Valve Closed	WR-P0007							DI	
2383	O	ZC-R021A	Position Control Output	Supernatent Pump P-R021A Speed Control Actuator Required Position	WR-P0007							AO	
2384	O	ZD-R021A	Open Status	Supernatent Pump P-R021A Outlet Manual Valve Open	WR-P0007							DI	
2385	O	ZT-R021A	Position Feedback	Supernatent Pump P-R021A Speed Control Actuator Position	WR-P0007							AI	
2386	O	ZB-R021B	Closed Status	Supernatent Pump P-R021A Outlet Control Valve Closed	WR-P0007							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2387	O	ZD-R021B	Open Status	Supernatent Pump P-R021A Outlet Control Valve Open	WR-P0007							DI	
2388	O	MM-R022A	Running Status	Supernatent Pump P-R022A Running	WR-P0007							DI	
2389	O	MN-R022A	Start Command	Supernatent Pump P-R022A Start	WR-P0007							DO	
2390	O	SI-R022A	Speed Indication	Supernatent Pump P-R022A Speed	WR-P0007							AI	
2391	O	TI-R022B	Temperature Indication	Supernatent Pump P-R022A Winding Temperature	WR-P0007							AI	
2392	O	TI-R022C	Temperature Indication	Supernatent Pump P-R022A Bottom Bearing Temperature	WR-P0007							AI	
2393	O	TI-R022D	Temperature Indication	Supernatent Pump P-R022A Top Bearing Temperature	WR-P0007							AI	
2394	O	UF-R022A	No Fault	Supernatent Pump P-R022A Running Fault	WR-P0007							DI	
2395	O	VI-R022A	Vibration Transmitter	Supernatent Pump P-R022A Vibration	WR-P0007							AI	
2396	O	YS-R022A	C/O/H Switch in Computer Position	Supernatent Pump P-R022A In Computer Mode	WR-P0007							DI	
2397	O	YS-R022A	C/O/H Switch in Computer Position	Supernatent Pump P-R022A Speed Control Actuator in Computer Mode	WR-P0007							DI	
2398	O	ZB-R022A	Closed Status	Supernatent Pump P-R022A Outlet Manual Valve Closed	WR-P0007							DI	
2399	O	ZC-R022A	Position Control Output	Supernatent Pump P-R022A Speed Control Actuator Required Position	WR-P0007							AO	
2400	O	ZD-R022A	Open Status	Supernatent Pump P-R022A Outlet Manual Valve Open	WR-P0007							DI	
2401	O	ZT-R022A	Position Feedback	Supernatent Pump P-R022A Speed Control Actuator Position	WR-P0007							AI	
2402	O	ZB-R022B	Closed Status	Supernatent Pump P-R022A Outlet Control Valve Closed	WR-P0007							DI	
2403	O	ZD-R022B	Open Status	Supernatent Pump P-R022A Outlet Control Valve Open	WR-P0007							DI	
2404	O	MM-R023A	Running Status	Supernatent Pump P-R023A Running	WR-P0007							DI	
2405	O	MN-R023A	Start Command	Supernatent Pump P-R023A Start	WR-P0007							DO	
2406	O	SI-R023A	Speed Indication	Supernatent Pump P-R023A Speed	WR-P0007							AI	
2407	O	TI-R023B	Temperature Indication	Supernatent Pump P-R023A Winding Temperature	WR-P0007							AI	
2408	O	TI-R023C	Temperature Indication	Supernatent Pump P-R023A Bottom Bearing Temperature	WR-P0007							AI	
2409	O	TI-R023D	Temperature Indication	Supernatent Pump P-R023A Top Bearing Temperature	WR-P0007							AI	
2410	O	UF-R023A	No Fault	Supernatent Pump P-R023A Running Fault	WR-P0007							DI	
2411	O	VI-R023A	Vibration Transmitter	Supernatent Pump P-R023A Vibration	WR-P0007							AI	
2412	O	YS-R023A	C/O/H Switch in Computer Position	Supernatent Pump P-R023A In Computer Mode	WR-P0007							DI	
2413	O	YS-R023A	C/O/H Switch in Computer Position	Supernatent Pump P-R023A Speed Control Actuator in Computer Mode	WR-P0007							DI	
2414	O	ZB-R023A	Closed Status	Supernatent Pump P-R023A Outlet Manual Valve Closed	WR-P0007							DI	
2415	O	ZC-R023A	Position Control Output	Supernatent Pump P-R023A Speed Control Actuator Required Position	WR-P0007							AO	
2416	O	ZD-R023A	Open Status	Supernatent Pump P-R023A Outlet Manual Valve Open	WR-P0007							DI	
2417	O	ZT-R023A	Position Feedback	Supernatent Pump P-R023A Speed Control Actuator Position	WR-P0007							AI	
2418	O	ZB-R023B	Closed Status	Supernatent Pump P-R023A Outlet Control Valve Closed	WR-P0007							DI	
2419	O	ZD-R023B	Open Status	Supernatent Pump P-R023A Outlet Control Valve Open	WR-P0007							DI	
2420	O	AF-R024A	Turbidity/ TSS Fault	Supernatent Pump Station Outlet Turbidity/TSS Monitor Fault	WR-P0007							AF	
2421	O	AI-R024A	Turbidity/ TSS Indication	Supernatent Pump Station Outlet Turbidity/TSS	WR-P0007							AI	
2422	O	YD-R024B	Solenoid Valve Output	Supernatent Pump Station Pump Control Valve Solenoid Operator	WR-P0007							DO	
2423	O	ZB-R024A	Closed Status	Surge Anticipatory Valve Closed	WR-P0007							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2424	O	ZD-R024A	Open Status	Surge Anticipatory Valve Open	WR-P0007							DI	
2425	O	ZB-R024B	Closed Status	Supernatent Pump Station Pump Control Valve Closed	WR-P0007							DI	
2426	O	ZD-R024B	Open Status	Supernatent Pump Station Pump Control Valve Open	WR-P0007							DI	
2427	O	LA-R100A	Level Alarm	Washwater Recovery Tank WRTR100A Low Low Level	WR-P0002							DI	
2428	O	LA-R100B	Level Alarm	Washwater Recovery Tank WRTR100A High High Level	WR-P0002							DI	
2429	O	LF-R100D	Level Fault	Washwater Recovery Tank WRTR100A Level	WR-P0002							DI	
2430	O	LI-R100D	Level Indication	Washwater Recovery Tank WRTR100A Level	WR-P0002							AI	
2431	O	LF-R100E	Turbidity/TSS Fault	Washwater Recovery Tank WRTR100A Turbidity/TSS Level	WR-P0002							DI	
2432	O	LI-R100E	Turbidity/TSS Indication	Washwater Recovery Tank WRTR100A Turbidity/TSS Level	WR-P0002							AI	
2433	O	MM-R100C	Running Status	Washwater Recovery Tank WRTR100A Sludge Pump Running	WR-P0002							DI	
2434	O	MN-R100C	Start Command	Washwater Recovery Tank WRTR100A Sludge Pump Start	WR-P0002							DO	
2435	O	SC-R100C	Speed Control Output	Washwater Recovery Tank WRTR100A Sludge Pump Required Speed	WR-P0002							AO	
2436	O	SI-R100C	Speed Indication	Washwater Recovery Tank WRTR100A Sludge Pump Speed	WR-P0002							AI	
2437	O	UF-R100C	No Fault	Washwater Recovery Tank WRTR100A Sludge Pump Fault	WR-P0002							DI	
2438	O	YB-R100A	Close Command	Washwater Recovery Tank WRTR100A Inlet Sluice Gate Closed	WR-P0001							DO	
2439	O	YD-R100A	Open Command	Washwater Recovery Tank WRTR100A Inlet Sluice Gate Open	WR-P0001							DO	
2440	O	YS-R100A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR100A Inlet Sluice Gate in Computer Mode	WR-P0001							DI	
2441	O	YB-R100A	Close Command	Washwater Recovery Tank WRTR100A Supernatent Valve Close	WR-P0002							DO	
2442	O	YD-R100A	Open Command	Washwater Recovery Tank WRTR100A Supernatent Valve Open	WR-P0002							DO	
2443	O	YS-R100A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR100A Supernatent Valve in Computer Mode	WR-P0002							DI	
2444	O	YS-R100C	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR100A Sludge Pump in Computer Mode	WR-P0002							DI	
2445	O	ZB-R100A	Closed Status	Washwater Recovery Tank WRTR100A Inlet Sluice Gate Open	WR-P0001							DI	
2446	O	ZD-R100A	Open Status	Washwater Recovery Tank WRTR100A Inlet Sluice Gate Closed	WR-P0001							DI	
2447	O	ZB-R100A	Closed Status	Washwater Recovery Tank WRTR100A Supernatent Valve Closed	WR-P0002							DI	
2448	O	ZD-R100A	Open Status	Washwater Recovery Tank WRTR100A Supernatent Valve Open	WR-P0002							DI	
2449	O	LA-R200A	Level Alarm	Washwater Recovery Tank WRTR200A Low Low Level	WR-P0003							DI	
2450	O	LA-R200B	Level Alarm	Washwater Recovery Tank WRTR200A High High Level	WR-P0003							DI	
2451	O	LF-R200D	Level Fault	Washwater Recovery Tank WRTR200A Level	WR-P0003							DI	
2452	O	LI-R200D	Level Indication	Washwater Recovery Tank WRTR200A Level	WR-P0003							AI	
2453	O	LF-R200E	Turbidity/TSS Fault	Washwater Recovery Tank WRTR200A Turbidity/TSS Level	WR-P0003							DI	
2454	O	LI-R200E	Turbidity/TSS Indication	Washwater Recovery Tank WRTR200A Turbidity/TSS Level	WR-P0003							AI	
2455	O	MM-R200C	Running Status	Washwater Recovery Tank WRTR200A Sludge Pump Running	WR-P0003							DI	
2456	O	MN-R200C	Start Command	Washwater Recovery Tank WRTR200A Sludge Pump Start	WR-P0003							DO	
2457	O	SC-R200C	Speed Control Output	Washwater Recovery Tank WRTR200A Sludge Pump Required Speed	WR-P0003							AO	
2458	O	SI-R200C	Speed Indication	Washwater Recovery Tank WRTR200A Sludge Pump Speed	WR-P0003							AI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2459	O	UF-R200C	No Fault	Washwater Recovery Tank WRTR200A Sludge Pump Fault	WR-P0003							DI	
2460	O	YB-R200A	Close Command	Washwater Recovery Tank WRTR200A Inlet Sluice Gate Closed	WR-P0001							DO	
2461	O	YD-R200A	Open Command	Washwater Recovery Tank WRTR200A Inlet Sluice Gate Open	WR-P0001							DO	
2462	O	YS-R200A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR200A Inlet Sluice Gate in Computer Mode	WR-P0001							DI	
2463	O	YB-R200A	Close Command	Washwater Recovery Tank WRTR200A Supernatent Valve Close	WR-P0003							DO	
2464	O	YD-R200A	Open Command	Washwater Recovery Tank WRTR200A Supernatent Valve Open	WR-P0003							DO	
2465	O	YS-R200A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR200A Supernatent Valve in Computer Mode	WR-P0003							DI	
2466	O	YS-R200C	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR200A Sludge Pump in Computer Mode	WR-P0003							DI	
2467	O	ZB-R200A	Closed Status	Washwater Recovery Tank WRTR200A Inlet Sluice Gate Open	WR-P0001							DI	
2468	O	ZD-R200A	Open Status	Washwater Recovery Tank WRTR200A Inlet Sluice Gate Closed	WR-P0001							DI	
2469	O	ZB-R200A	Closed Status	Washwater Recovery Tank WRTR200A Supernatent Valve Closed	WR-P0003							DI	
2470	O	ZD-R200A	Open Status	Washwater Recovery Tank WRTR200A Supernatent Valve Open	WR-P0003							DI	
2471	O	LA-R300A	Level Alarm	Washwater Recovery Tank WRTR300A Low Low Level	WR-P0004							DI	
2472	O	LA-R300B	Level Alarm	Washwater Recovery Tank WRTR300A High High Level	WR-P0004							DI	
2473	O	LF-R300D	Level Fault	Washwater Recovery Tank WRTR300A Level	WR-P0004							DI	
2474	O	LI-R300D	Level Indication	Washwater Recovery Tank WRTR300A Level	WR-P0004							AI	
2475	O	LF-R300E	Turbidity/TSS Fault	Washwater Recovery Tank WRTR300A Turbidity/TSS Level	WR-P0004							DI	
2476	O	LI-R300E	Turbidity/TSS Indication	Washwater Recovery Tank WRTR300A Turbidity/TSS Level	WR-P0004							AI	
2477	O	MM-R300C	Running Status	Washwater Recovery Tank WRTR300A Sludge Pump Running	WR-P0004							DI	
2478	O	MN-R300C	Start Command	Washwater Recovery Tank WRTR300A Sludge Pump Start	WR-P0004							DO	
2479	O	SC-R300C	Speed Control Output	Washwater Recovery Tank WRTR300A Sludge Pump Required Speed	WR-P0004							AO	
2480	O	SI-R300C	Speed Indication	Washwater Recovery Tank WRTR300A Sludge Pump Speed	WR-P0004							AI	
2481	O	UF-R300C	No Fault	Washwater Recovery Tank WRTR300A Sludge Pump Fault	WR-P0004							DI	
2482	O	YB-R300A	Close Command	Washwater Recovery Tank WRTR300A Inlet Sluice Gate Closed	WR-P0001							DO	
2483	O	YD-R300A	Open Command	Washwater Recovery Tank WRTR300A Inlet Sluice Gate Open	WR-P0001							DO	
2484	O	YS-R300A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR300A Inlet Sluice Gate in Computer Mode	WR-P0001							DI	
2485	O	YB-R300A	Close Command	Washwater Recovery Tank WRTR300A Supernatent Valve Close	WR-P0004							DO	
2486	O	YD-R300A	Open Command	Washwater Recovery Tank WRTR300A Supernatent Valve Open	WR-P0004							DO	
2487	O	YS-R300A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR300A Supernatent Valve in Computer Mode	WR-P0004							DI	
2488	O	YS-R300C	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR300A Sludge Pump in Computer Mode	WR-P0004							DI	
2489	O	ZB-R300A	Closed Status	Washwater Recovery Tank WRTR300A Inlet Sluice Gate Open	WR-P0001							DI	
2490	O	ZD-R300A	Open Status	Washwater Recovery Tank WRTR300A Inlet Sluice Gate Closed	WR-P0001							DI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2491	O	ZB-R300A	Closed Status	Washwater Recovery Tank WRTR300A Supernatent Valve Closed	WR-P0004							DI	
2492	O	ZD-R300A	Open Status	Washwater Recovery Tank WRTR300A Supernatent Valve Open	WR-P0004							DI	
2493	O	LA-R400A	Level Alarm	Washwater Recovery Tank WRTR400A Low Low Level	WR-P0005							DI	
2494	O	LA-R400B	Level Alarm	Washwater Recovery Tank WRTR400A High High Level	WR-P0005							DI	
2495	O	LF-R400D	Level Fault	Washwater Recovery Tank WRTR400A Level	WR-P0005							DI	
2496	O	LI-R400D	Level Indication	Washwater Recovery Tank WRTR400A Level	WR-P0005							AI	
2497	O	LF-R400E	Turbidity/TSS Fault	Washwater Recovery Tank WRTR400A Turbidity/TSS Level	WR-P0005							DI	
2498	O	LI-R400E	Turbidity/TSS Indication	Washwater Recovery Tank WRTR400A Turbidity/TSS Level	WR-P0005							AI	
2499	O	MM-R400C	Running Status	Washwater Recovery Tank WRTR400A Sludge Pump Running	WR-P0005							DI	
2500	O	MN-R400C	Start Command	Washwater Recovery Tank WRTR400A Sludge Pump Start	WR-P0005							DO	
2501	O	SC-R400C	Speed Control Output	Washwater Recovery Tank WRTR400A Sludge Pump Required Speed	WR-P0005							AO	
2502	O	SI-R400C	Speed Indication	Washwater Recovery Tank WRTR400A Sludge Pump Speed	WR-P0005							AI	
2503	O	UF-R400C	No Fault	Washwater Recovery Tank WRTR400A Sludge Pump Fault	WR-P0005							DI	
2504	O	YB-R400A	Close Command	Washwater Recovery Tank WRTR400A Inlet Sluice Gate Closed	WR-P0001							DO	
2505	O	YD-R400A	Open Command	Washwater Recovery Tank WRTR400A Inlet Sluice Gate Open	WR-P0001							DO	
2506	O	YS-R400A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR400A Inlet Sluice Gate in Computer Mode	WR-P0001							DI	
2507	O	YB-R400A	Close Command	Washwater Recovery Tank WRTR400A Supernatent Valve Close	WR-P0005							DO	
2508	O	YD-R400A	Open Command	Washwater Recovery Tank WRTR400A Supernatent Valve Open	WR-P0005							DO	
2509	O	YS-R400A	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR400A Supernatent Valve in Computer Mode	WR-P0005							DI	
2510	O	YS-R400C	C/O/H Switch in Computer Position	Washwater Recovery Tank WRTR400A Sludge Pump in Computer Mode	WR-P0005							DI	
2511	O	ZB-R400A	Closed Status	Washwater Recovery Tank WRTR400A Inlet Sluice Gate Open	WR-P0001							DI	
2512	O	ZD-R400A	Open Status	Washwater Recovery Tank WRTR400A Inlet Sluice Gate Closed	WR-P0001							DI	
2513	O	ZB-R400A	Closed Status	Washwater Recovery Tank WRTR400A Supernatent Valve Closed	WR-P0005							DI	
2514	O	ZD-R400A	Open Status	Washwater Recovery Tank WRTR400A Supernatent Valve Open	WR-P0005							DI	
2515	O	AI-R500B	TSS Indication	Gravity Thickener GT500A TSS	WR-P0008							AI	
2516	O	AI-R500C	Turbidity Indication	Gravity Thickener GT500A Turbidity	WR-P0008							AI	
2517	O	LA-R500A	Level Alarm	Gravity Thickener GT500A High Level	WR-P0008							DI	
2518	O	MM-R500A	Running Status	Gravity Thickener Running	WR-P0008							DI	
2519	O	MN-R500A	Start Command	Gravity Thickener in Computer Start	WR-P0008							DO	
2520	O	UF-R500B	TSS Fault	Gravity Thickener GT500A TSS Fault	WR-P0008							DI	
2521	O	UF-R500C	Turbidity Fault	Gravity Thickener GT500A Turbidity Fault	WR-P0008							DI	
2522	O	VA-R500A	Torque Alarm	Gravity Thickener GT500A High Torque	WR-P0008							DI	
2523	O	YS-R500A	C/O/H Switch in Computer Position	Gravity Thickener in Computer Mode	WR-P0008							DI	
2524	O	AI-R600B	TSS Indication	Gravity Thickener GT600A TSS	WR-P0008							AI	
2525	O	AI-R600C	Turbidity Indication	Gravity Thickener GT600A Turbidity	WR-P0008							AI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2526	O	LA-R600A	Level Alarm	Gravity Thickener GT600A High Level	WR-P0008							DI	
2527	O	MM-R600A	Running Status	Gravity Thickener Running	WR-P0008							DI	
2528	O	MN-R600A	Start Command	Gravity Thickener in Computer Start	WR-P0008							DO	
2529	O	UF-R600B	TSS Fault	Gravity Thickener GT600A TSS Fault	WR-P0008							DI	
2530	O	UF-R600C	Turbidity Fault	Gravity Thickener GT600A Turbidity Fault	WR-P0008							DI	
2531	O	VA-R600A	Torque Alarm	Gravity Thickener GT600A High Torque	WR-P0008							DI	
2532	O	YS-R600A	C/O/H Switch in Computer Position	Gravity Thickener in Computer Mode	WR-P0008							DI	
2533	O	LA-R710A	Level Alarm	Thickened Sludge Tank TKR710 Low Low Level	WR-P0009							DI	
2534	O	LA-R710B	Level Alarm	Thickened Sludge Tank TKR710 High High Level	WR-P0009							DI	
2535	O	LF-R710D	Level Fault	Thickened Sludge Tank TKR710 Level Fault	WR-P0009							DI	
2536	O	LI-R710D	Level Indication	Thickened Sludge Tank TKR710 Level	WR-P0009							AI	
2537	O	MM-R710B	Running Status	Thickened Sludge Tank TKR710 Sludge Pump P-R710B Running	WR-P0009							DI	
2538	O	MN-R710B	Start Command	Thickened Sludge Tank TKR710 Sludge Pump P-R710B Start	WR-P0009							DO	
2539	O	MM-R710C	Running Status	Thickened Sludge Tank TKR710 Mixer MXR-R710C Running	WR-P0009							DI	
2540	O	MN-R710C	Start Command	Thickened Sludge Tank TKR710 Mixer MXR-R710C Start	WR-P0009							DO	
2541	O	SC-R710B	Speed Control Output	Thickened Sludge Tank TKR710 Sludge Pump P-R710B Required Speed	WR-P0009							AO	
2542	O	SI-R710B	Speed Indication	Thickened Sludge Tank TKR710 Sludge Pump P-R710B Speed	WR-P0009							AI	
2543	O	SC-R710C	Speed Control Output	Thickened Sludge Tank TKR710 Mixer MXR-R710C Required Speed	WR-P0009							AO	
2544	O	SI-R710C	Speed Indication	Thickened Sludge Tank TKR710 Mixer MXR-R710C Speed	WR-P0009							AI	
2545	O	UF-R710B	No Fault	Thickened Sludge Tank TKR710 Sludge Pump P-R710B Fault	WR-P0009							DI	
2546	O	UF-R710C	No Fault	Thickened Sludge Tank TKR710 Mixer MXR-R710C Fault	WR-P0009							DI	
2547	O	YB-R710A	Close Command	Gravity Thickener GTR500A to Thickened Sludge Equalization Tank TKR710 Sludge Valve Close	WR-P0009							DO	
2548	O	YD-R710A	Open Command	Gravity Thickener GTR500A to Thickened Sludge Equalization Tank TKR710 Sludge Valve Open	WR-P0009							DO	
2549	O	YS-R710A	C/O/H Switch in Computer Position	Gravity Thickener GTR500A to Thickened Sludge Equalization Tank TKR710 Sludge Valve in Computer Mode	WR-P0009							DI	
2550	O	YS-R710B	C/O/H Switch in Computer Position	Thickened Sludge Tank TKR710 Sludge Pump P-R710B in Computer Mode	WR-P0009							DI	
2551	O	YS-R710C	C/O/H Switch in Computer Position	Thickened Sludge Tank TKR710 Mixer MXR-R710C in Computer Mode	WR-P0009							DI	
2552	O	ZB-R710A	Closed Status	Gravity Thickener GTR500A to Thickened Sludge Equalization Tank TKR710 Sludge Valve Closed	WR-P0009							DI	
2553	O	ZD-R710A	Open Status	Gravity Thickener GTR500A to Thickened Sludge Equalization Tank TKR710 Sludge Valve Open	WR-P0009							DI	
2554	O	LA-R720A	Level Alarm	Thickened Sludge Tank TKR720 Low Low Level	WR-P0009							DI	
2555	O	LA-R720B	Level Alarm	Thickened Sludge Tank TKR720 High High Level	WR-P0009							DI	
2556	O	LF-R720D	Level Fault	Thickened Sludge Tank TKR720 Level Fault	WR-P0009							DI	
2557	O	LI-R720D	Level Indication	Thickened Sludge Tank TKR720 Level	WR-P0009							AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2558	O	MM-R720B	Running Status	Thickened Sludge Tank TKR720 Sludge Pump P-R720B Running	WR-P0009							DI	
2559	O	MN-R720B	Start Command	Thickened Sludge Tank TKR720 Sludge Pump P-R720B Start	WR-P0009							DO	
2560	O	MM-R720C	Running Status	Thickened Sludge Tank TKR720 Mixer MXR-R720C Running	WR-P0009							DI	
2561	O	MN-R720C	Start Command	Thickened Sludge Tank TKR720 Mixer MXR-R720C Start	WR-P0009							DO	
2562	O	SC-R720B	Speed Control Output	Thickened Sludge Tank TKR720 Sludge Pump P-R720B Required Speed	WR-P0009							AO	
2563	O	SI-R720B	Speed Indication	Thickened Sludge Tank TKR720 Sludge Pump P-R720B Speed	WR-P0009							AI	
2564	O	SC-R720C	Speed Control Output	Thickened Sludge Tank TKR720 Mixer MXR-R720C Required Speed	WR-P0009							AO	
2565	O	SI-R720C	Speed Indication	Thickened Sludge Tank TKR720 Mixer MXR-R720C Speed	WR-P0009							AI	
2566	O	UF-R720B	No Fault	Thickened Sludge Tank TKR720 Sludge Pump P-R720B Fault	WR-P0009							DI	
2567	O	UF-R720C	No Fault	Thickened Sludge Tank TKR720 Mixer MXR-R720C Fault	WR-P0009							DI	
2568	O	YB-R720A	Close Command	Gravity Thickener GTR600A to Thickened Sludge Equalization Tank TKR720 Sludge Valve Close	WR-P0009							DO	
2569	O	YD-R720A	Open Command	Gravity Thickener GTR600A to Thickened Sludge Equalization Tank TKR720 Sludge Valve Open	WR-P0009							DO	
2570	O	YS-R720A	C/O/H Switch in Computer Position	Gravity Thickener GTR600A to Thickened Sludge Equalization Tank TKR720 Sludge Valve in Computer Mode	WR-P0009							DI	
2571	O	YS-R720B	C/O/H Switch in Computer Position	Thickened Sludge Tank TKR720 Sludge Pump P-R720B in Computer Mode	WR-P0009							DI	
2572	O	YS-R720C	C/O/H Switch in Computer Position	Thickened Sludge Tank TKR720 Mixer MXR-R720C in Computer Mode	WR-P0009							DI	
2573	O	ZB-R720A	Closed Status	Gravity Thickener GTR600A to Thickened Sludge Equalization Tank TKR720 Sludge Valve Closed	WR-P0009							DI	
2574	O	ZD-R720A	Open Status	Gravity Thickener GTR600A to Thickened Sludge Equalization Tank TKR720 Sludge Valve Open	WR-P0009							DI	
2575	O	AF-R730B	TSS Fault	Thickened Sludge to Freeze Thaw Ponds TSS Fault	WR-P0009							DI	
2576	O	AI-R730B	TSS Indication	Thickened Sludge to Freeze Thaw Ponds TSS	WR-P0009							AI	
2577	O	FI-R730A	Flow Indication	Thickened Sludge to Freeze Thaw Ponds Flow Rate	WR-P0009							AI	
2578	O	FQ-R730A	Flow Pulse	Thickened Sludge to Freeze Thaw Ponds Flow Total	WR-P0009							DI	
2579	O	YD-R730A	Solenoid Valve	Thickened Sludge to Freeze Thaw Ponds Pump Outlet Control Valve Open	WR-P0009							DO	
2580	O	ZB-R730A	Closed Status	Thickened Sludge to Freeze Thaw Ponds Pump Outlet Control Valve Closed	WR-P0009							DI	
2581	O	ZD-R730A	Open Status	Thickened Sludge to Freeze Thaw Ponds Pump Outlet Control Valve Open	WR-P0009							DI	
2582	O	LA-R920A	Level Alarm	Dewatering Pump Station TKR920A High High Level	WR-P0012							DI	
2583	O	LF-R920A	Level Fault	Dewatering Pump Station TKR920A Level Fault	WR-P0012							DI	
2584	O	LI-R920A	Level Indication	Dewatering Pump Station TKR920A Level	WR-P0012							AI	
2585	O	LA-R920B	Level Alarm	Dewatering Pump Station TKR920A Low Low Level	WR-P0012							DI	
2586	O	MM-R921A	Running Status	Freeze Thaw Ponds Dewatering Pump P-R921A Running	WR-P0012							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2587	O	MN-R921A	Start Command	Freeze Thaw Ponds Dewatering Pump P-R921A Start	WR-P0012							DO	
2588	O	UF-R921A	No Fault	Freeze Thaw Ponds Dewatering Pump P-R921A Fault	WR-P0012							DI	
2589	O	YS-R921A	C/O/H Switch in Computer Position	Freeze Thaw Ponds Dewatering Pump P-R921A in Computer Mode	WR-P0012							DI	
2590	O	MM-R922A	Running Status	Freeze Thaw Ponds Dewatering Pump P-R922A Running	WR-P0012							DI	
2591	O	MN-R922A	Start Command	Freeze Thaw Ponds Dewatering Pump P-R922A Start	WR-P0012							DO	
2592	O	UF-R922A	No Fault	Freeze Thaw Ponds Dewatering Pump P-R922A Fault	WR-P0012							DI	
2593	O	YS-R922A	C/O/H Switch in Computer Position	Freeze Thaw Ponds Dewatering Pump P-R922A in Computer Mode	WR-P0012							DI	
2594	O	AI-R924A	TSS Indication	Combined Dewatering Pump Outlet TSS	WR-P0012							AI	
2595	O	AT-R924A	TSS Fault	Combined Dewatering Pump Outlet TSS Fault	WR-P0012							DI	
2596	O	FI-R924B	Flow Indication	Combined Dewatering Pump Outlet Flow Rate	WR-P0012							AI	
2597	O	FQ-R924B	Flow Pulse	Combined Dewatering Pump Outlet Flow Total	WR-P0012							DI	
2598	O	ZB-T002A	Closed Status	Clearwell Cell 1 & 2 Dividing Wall Sluice Gate Closed	WT-P0001							DI	
2599	O	ZD-T002A	Open Status	Clearwell Cell 1 & 2 Dividing Wall Sluice Gate Open	WT-P0001							DI	
2600	O	ZB-T003A	Closed Status	Clearwell Outlet Chamber Dividing Wall Sluice Gate Closed	WT-P0001							DI	
2601	O	ZD-T003A	Open Status	Clearwell Outlet Chamber Dividing Wall Sluice Gate Open	WT-P0001							DI	
2602	O	AI-T101A	Ammonia Indication	Clearwell Inlet Ammonia	WT-P0001							AI	
2603	O	AI-T101A	Total/ Combined Chlorine Indication	Clearwell Inlet Total/ Combined Chlorine	WT-P0001							AI	
2604	O	AI-T101A	Free Chlorine Indication	Clearwell Inlet Free Chlorine	WT-P0001							AI	
2605	O	FA-T101A	Flow Alarm	Clearwell Analyser Sample Low Flow	WT-P0001							DI	
2606	O	LF-T101A	Level Fault	Clearwell Cell No.1 Level	WT-P0001							DI	
2607	O	LI-T101A	Level Indication	Clearwell Cell No.1 Level	WT-P0001							AI	
2608	O	LF-T101B	Level Fault	Clearwell Cell No.1 Level	WT-P0001							DI	
2609	O	LI-T101B	Level Indication	Clearwell Cell No.1 Level	WT-P0001							AI	
2610	O	MM-T101A	Running Status	Clearwell Analyser Sample Pump Running	WT-P0001							DI	
2611	O	MM-T101A	Running Status	Clearwell Analyser Sample Pump Running	WT-P0001							DI	
2612	O	MN-T101A	Start Command	Clearwell Analyser Sample Pump Start	WT-P0001							DO	
2613	O	MN-T101A	Start Command	Clearwell Analyser Sample Pump Start	WT-P0001							DO	
2614	O	YS-T101A	C/O/H Switch in Computer Position	Clearwell Analyser Sample Pump in Computer Mode	WT-P0001							DI	
2615	O	YS-T101A	C/O/H Switch in Computer Position	Clearwell Analyser Sample Pump in Computer Mode	WT-P0001							DI	
2616	O	ZB-T101A	Closed Status	Clearwell Cell 1 Inlet Sluice Gate Closed	WT-P0001							DI	
2617	O	ZD-T101A	Open Status	Clearwell Cell 1 Inlet Sluice Gate Open	WT-P0001							DI	
2618	O	AI-T102A	pH Indication	Clearwell Inlet pH	WT-P0001							AI	
2619	O	ZB-T102A	Closed Status	Clearwell Cell 1 Outlet Sluice Gate Closed	WT-P0001							DI	
2620	O	ZD-T102A	Open Status	Clearwell Cell 1 Outlet Sluice Gate Open	WT-P0001							DI	
2621	O	AI-T103A	Turbiditiy Indication	Clearwell Inlet Turbidity	WT-P0001							AI	
2622	O	AI-T201A	Ammonia Indication	Clearwell Inlet Ammonia	WT-P0001							AI	
2623	O	AI-T201A	Total/ Combined Chlorine Indication	Clearwell Inlet Total/ Combined Chlorine	WT-P0001							AI	
2624	O	AI-T201A	Free Chlorine Indication	Clearwell Inlet Free Chlorine	WT-P0001							AI	
2625	O	FS-T201A	Flow Alarm	Clearwell Analyser Sample Low Flow	WT-P0001							di	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

PLC I/O INDEX

			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2626	O	LF-T201A	Level Fault	Clearwell Cell No.2 Level	WT-P0001							DI	
2627	O	LI-T201A	Level Indication	Clearwell Cell No.2 Level	WT-P0001							AI	
2628	O	LF-T201B	Level Fault	Clearwell Cell No.2 Level	WT-P0001							DI	
2629	O	LI-T201B	Level Indication	Clearwell Cell No.2 Level	WT-P0001							AI	
2630	O	ZB-T201A	Closed Status	Clearwell Cell 2 Inlet Sluice Gate Closed	WT-P0001							DI	
2631	O	ZD-T201A	Open Status	Clearwell Cell 2 Inlet Sluice Gate Open	WT-P0001							DI	
2632	O	AI-T202A	pH Indication	Clearwell Inlet pH	WT-P0001							AI	
2633	O	ZB-T202A	Closed Status	Clearwell Cell 2 Outlet Sluice Gate Closed	WT-P0001							DI	
2634	O	ZD-T202A	Open Status	Clearwell Cell 2 Outlet Sluice Gate Open	WT-P0001							DI	
2635	O	AI-T203A	Turbiditiy Indication	Clearwell Inlet Turbidity	WT-P0001							AI	
2636	O	MM-H001	Running Status	Supply fan MUA-H001 status	WB-H0501							DI	
2637	O	TA-H001A	Temperature Alarm	Filter Gallery Temperature T-H001A	WB-H0501							AI	
2638	O	TA-H001B	Temperature Alarm	Filter Pipe Gallery Temperature T-H001B	WB-H0501							AI	
2639	O	TA-H001C	Temperature Alarm	Effluent Gate Room Temperature T-H001C	WB-H0501							AI	
2640	O	MM-H002	Running Status	Exhaust fan EF-H002 status	WB-H0501							DI	
2641	O	MM-H003	Running Status	Exhaust fan EF-H003 status	WB-H0501							DI	
2642	O	MM-H004	Running Status	Exhaust fan EF-H004 status	WB-H0501							DI	
2643	O	MM-H005	Running Status	Exhaust fan EF-H005 status	WB-H0501							DI	
2644	O	MM-H011	Running Status	Supply fan MUA-H011 status	WB-H0501							DI	
2645	O	TA-H011A	Temperature Alarm	Pilot Plant Room Temperature T-H011A	WB-H0501							AI	
2646	O	MM-H012	Running Status	Supply fan MUA-H012 status	WB-H0501							DI	
2647	O	TA-H012A	Temperature Alarm	Wash Water Recovery Gallery Temperature T-H012A	WB-H0501							AI	
2648	O	MM-H013	Running Status	Exhaust fan EF-H013 status	WB-H0501							DI	
2649	O	MM-H014	Running Status	Exhaust fan EF-H014 status	WB-H0501							DI	
2650	O	MM-H015	Running Status	Exhaust fan EF-H015 status	WB-H0501							DI	
2651	O	TA-H015D	Temperature Alarm	Mechanical Room No.2 Temperature T-H015D	WB-H0501							AI	
2652	O	MM-H040	Running Status	Exhaust fan EF-H040 status	WB-H0501							DI	
2653	O	TA-H040A	Temperature Alarm	Blower Room Temperature T-H040A	WB-H0501							AI	
2654	O	QA-	General Alarm	Filter Gallery System General Alarm	WB-H0501							DI	
2655	O	QA-	General Alarm	Chemical Injection area System General Alarm	WB-H0501							DI	
2656	O	QA-	General Alarm	Blower Room System General Alarm	WB-H0501							DI	
2657	O	QA-	General Alarm	Pilot Plant Room System General Alarm	WB-H0501							DI	
2658	O	QA-	General Alarm	Wash Water Recovery Gallery System General Alarm	WB-H0501							DI	
2659	O	QA-	General Alarm	Mechanical Room No.2 System General Alarm	WB-H0501							DI	
2660	O	MM-H021	Running Status	Supply fan MUA-H021 status	WB-H0502							DI	
2661	O	MM-H022	Running Status	Supply fan HRU-H022 status	WB-H0502							DI	
2662	O	MM-H022	Running Status	Exhaust fan HRU-H022 status	WB-H0502							DI	
2663	O	TA-H022	Temperature Alarm	HRU-H022 Supply air Temperature	WB-H0502							AI	
2664	O	TA-H022A	Temperature Alarm	Ozone Room Temperature T-H022A	WB-H0502							AI	
2665	O	TA-H022B	Temperature Alarm	Access Corridor No.2 Temperature T-H022B	WB-H0502							AI	
2666	O	TA-H022C	Temperature Alarm	Access Corridor No.3 Temperature T-H022C	WB-H0502							AI	

I/O POINT TYPES: TCP = Modbus/TCP Ethernet, AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2667	O	TA-H022D	Temperature Alarm	Access Corridor No.5 Temperature T-H022C	WB-H0502							AI	
2668	O	TA-H022E	Temperature Alarm	Access Corridor No.6 Temperature T-H022C	WB-H0502							AI	
2669	O	MM-H023	Running Status	Exhaust fan EF-H023 status	WB-H0502							DI	
2670	O	MM-H023	Running Status	Exhaust fan EF-H023 status	WB-H0502							DI	
2671	O	MM-H031	Running Status	Supply fan MAU-H031 status	WB-H0502							DI	
2672	O	TA-H031A	Temperature Alarm	Polymer Feed and Preparation Room Temperature T-H031A	WB-H0502							AI	
2673	O	TA-H031B	Temperature Alarm	Receiving Bay Temperature T-H031B	WB-H0502							AI	
2674	O	TA-H031C	Temperature Alarm	Polymer Storage Room Temperature T-H031C	WB-H0502							AI	
2675	O	MM-H032	Running Status	Supply fan MAU-H032 status	WB-H0502							DI	
2676	O	TA-H032A	Temperature Alarm	Peroxide Room Temperature T-H032A	WB-H0502							AI	
2677	O	TA-H032A	Temperature Alarm	Electrical Room No.2 Temperature T-H035A	WB-H0502							AI	
2678	O	MM-H033	Running Status	Supply fan MAU-H033 status	WB-H0502							DI	
2679	O	TA-H033A	Temperature Alarm	SBS Storage & Feed Room Temperature T-H033A	WB-H0502							AI	
2680	O	MM-H035	Running Status	Supply fan AHU-H035 status	WB-H0502							DI	
2681	O	MM-H037	Running Status	Exhaust fan EF-H037 status	WB-H0502							DI	
2682	O	MM-H038	Running Status	Exhaust fan EF-H038 status	WB-H0502							DI	
2683	O	MM-H039	Running Status	Exhaust fan EF-H039 status	WB-H0502							DI	
2684	O	AIT-	Level Fault	High Ozone Concentration Detected	WB-H0502							DO	
2685	O	QA-	General Alarm	Ozone Emergency System General Alarm	WB-H0502							DI	
2686	O	QA-	General Alarm	Ozone Room System General Alarm	WB-H0502							DI	
2687	O	QA-	General Alarm	Polymer Facility System General Alarm	WB-H0502							DI	
2688	O	QA-	General Alarm	Peroxide Room System General Alarm	WB-H0502							DI	
2689	O	QA-	General Alarm	SBS Room System General Alarm	WB-H0502							DI	
2690	O	QA-	General Alarm	Electrical Room No.2 System General Alarm	WB-H0502							DI	
2691	O	MM-H034E	Running Status	Exhaust fan HRU-H034E status	WB-H0503							DI	
2692	O	MM-H034S	Running Status	Supply fan HRU-H034S status	WB-H0503							DI	
2693	O	TA-H034A	Temperature Alarm	Maintenance Workshop Room Temperature T-H034A	WB-H0503							AI	
2694	O	MM-H041	Running Status	Exhaust fan EF-H041 status	WB-H0503							DI	
2695	O	TA-H041A	Temperature Alarm	Mechanical Room No.3 Room Temperature T-H041A	WB-H0503							AI	
2696	O	MM-H043	Running Status	Exhaust fan EF-H043 status	WB-H0503							DI	
2697	O	MM-H044	Running Status	Exhaust fan EF-H044 status	WB-H0503							DI	
2698	O	MM-H051	Running Status	Supply fan MAU-H051 status	WB-H0503							DI	
2699	O	TA-H051A	Temperature Alarm	DAF Process Gallery Temperature T-H051A	WB-H0503							AI	
2700	O	TA-H051B	Temperature Alarm	DAF Pump Gallery Temperature T-H051B	WB-H0503							AI	
2701	O	TA-H051C	Temperature Alarm	DAF Influent Gallery Temperature T-H051C	WB-H0503							AI	
2702	O	MM-H052	Running Status	Exhaust fan EF-H052 status	WB-H0503							DI	
2703	O	MM-H053	Running Status	Transfer fan EF-H053 status	WB-H0503							DI	
2704	O	MM-H062	Running Status	Supply fan AHU-H062 status	WB-H0503							DI	
2705	O	TA-H062A	Temperature Alarm	Electrical Room No.1 Temperature T-H062A	WB-H0503							AI	
2706	O	QA-	General Alarm	Maintenance Workshop System General Alarm	WB-H0503							DI	
2707	O	QA-	General Alarm	Maintenance Workshop WR Exhaust System General Alarm	WB-H0503							DI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2708	O	QA-	General Alarm	Mechanical Room No.3 System General Alarm	WB-H0503							DI	
2709	O	QA-	General Alarm	DAF Process System General Alarm	WB-H0503							DI	
2710	O	QA-	General Alarm	Electrical Room No.1 System General Alarm	WB-H0503							DI	
2711	O	MM-H061	Running Status	Supply fan AHU-H061 status	WB-H0504							DI	
2712	O	TA-H061A	Temperature Alarm	Raw Water Pump Room Temperature T-H061A	WB-H0504							AI	
2713	O	TA-H061B	Temperature Alarm	Raw Water Pump Room Temperature T-H061B	WB-H0504							AI	
2714	O	MM-H063	Running Status	Exhaust fan EF-H063 status	WB-H0504							DI	
2715	O	TA-H063A	Temperature Alarm	Fire Pump Room Temperature T-H063A	WB-H0504							AI	
2716	O	MM-H064	Running Status	Exhaust fan EF-H064 status	WB-H0504							DI	
2717	O	TA-H064A	Temperature Alarm	Mechanical Room No.1 Temperature T-H064A	WB-H0504							AI	
2718	O	MM-H071	Running Status	Supply fan AHU-H071 status	WB-H0504							DI	
2719	O	MM-H073	Running Status	Exhaust fan EF-H073 status	WB-H0504							DI	
2720	O	MM-H074	Running Status	Exhaust fan EF-H074 status	WB-H0504							DI	
2721	O	TA-H074A	Temperature Alarm	Mechanical Room No.1 Temperature T-H074A	WB-H0504							AI	
2722	O	MM-H075	Running Status	Exhaust fan EF-H075 status	WB-H0504							DI	
2723	O	MM-H076	Running Status	Exhaust fan EF-H076 status	WB-H0504							DI	
2724	O	MM-H079	Running Status	Exhaust fan EF-H079 status	WB-H0504							DI	
2725	O	TA-H097A	Temperature Alarm	Electrical Closet Temperature T-H097A	WB-H0504							AI	
2726	O	QA-	General Alarm	Raw Water Pump Room System General Alarm	WB-H0504							DI	
2727	O	QA-	General Alarm	Fire Pump Room System General Alarm	WB-H0504							DI	
2728	O	QA-	General Alarm	Admin Area Ventilation System General Alarm	WB-H0504							DI	
2729	O	QA-	General Alarm	Sanitary Exhaust System General Alarm	WB-H0504							DI	
2730	O	QA-	General Alarm	Heat Pump HP-H0XX System General Alarm	WB-H0504							DI	
2731	O	QA-	General Alarm	Electrical Closet Exhaust System General Alarm	WB-H0504							DI	
2732	O	QA-	General Alarm	Mechanical Room No.1 System General Alarm	WB-H0504							DI	
2733	O	QA-	General Alarm	Mechanical Room No.1 System General Alarm	WB-H0504							DI	
2734	O	MM-H0XX	Running Status	Heat Pump HP-H0XX status	WB-H0504							DI	
2735	O	TA-H0XX	Temperature Alarm	Zone Temperature T-H0XXA	WB-H0504							AI	
2736	O	MM-H007	Running Status	Cooling Water Pump P-H007 status	WB-H0506							DI	
2737	O	MM-H008	Running Status	Cooling Water Pump P-H008 status	WB-H0506							DI	
2738	O	MM-H016	Running Status	Condenser Water Pump P-H016 status	WB-H0506							DI	
2739	O	MM-H017	Running Status	Condenser Water Pump P-H017 status	WB-H0506							DI	
2740	O	MM-H110A	Running Status	Sprinkler and Standpipes Fire Pump Running	WB-H0561							DI	
2741	O	UF-H110A	No Fault	Sprinkler and Standpipes Fire Pump Fault	WB-H0561							DI	
2742	O	MM-H120A	Running Status	Sprinkler and Standpipes Jockey Pump Running	WB-H0561							DI	
2743	O	UF-H120A	No Fault	Sprinkler and Standpipes Jockey Pump Fault	WB-H0561							DI	
2744	O	MM-H130A	Running Status	Outdoor Hydrant Emergency Pump Running	WB-H0561							DI	
2745	O	UF-H130A	No Fault	Outdoor Hydrant Emergency Pump Fault	WB-H0561							DI	
2746	O	MM-H140A	Running Status	Outdoor Hydrant Jockey Pump Running	WB-H0561							DI	
2747	O	UF-H140A	No Fault	Outdoor Hydrant Jockey Pump Fault	WB-H0561							DI	
2748	O	FI-H153A	Flow Indication	Fire Pump Test Line Flow Rate	WB-H0561							AI	

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			DESCRIPTION			I/O SPECIFICATION							
RECORD NO.	REV. NO.	TAG NAME	FUNCTION	SERVICE	P&ID DRAWING	ENG. UNITS	SCALE LOW	SCALE HIGH	ALARMS LOW	ALARMS HIGH	PLC CABINET	I/O TYPE	I/O ADDRESS
2749		YY-H080A	HVAC Shutdown Command	Water Treatment Plant in Standby Power Mode								DO	

INSTRUMENT INDEX

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

1.2 Instrument Index

.1 The following spreadsheet gives an itemized list of the instrumentation included as part of this Work.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

INSTRUMENT INDEX

RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0001	O	FE-C001B	Flow Element	Standby Emulsion Polymer Flow to Storage Tanks					Flange	Mech. Contractor	Mech. Contractor	50mm	I100	WC-P0007	WB-A0453	WB-A0453	WC-E0112
0002	O	FT-C001B	Flow Indicator Transmitter	Standby Emulsion Polymer Flow to Storage Tanks			120V		Wall/Stand	Mech. Contractor	Elec. Contractor		I100	WC-P0007	WB-A0453	WB-A0402	WC-E0112
0003	O	WE-C001B	Load Cells	Standby Emulsion Polymer Weight										WC-P0007			
0004	O	WT-C001B	Weight Indicator Transmitter	Standby Emulsion Polymer Weight										WC-P0007			
0005	O	LS-C005A	Conductivity Level Switch	Polymer Spill Containment High Level			120V	6mm from floor of containment	Bracket	E&I Contractor	E&I Contractor	To measure any liquid in containment	I126	WC-P0007	WB-A0458	N/A	NOD
0006	O	LS-C020A	Level Switch	Filter Polymer Bulk Powder Unloading Hopper Low			120V		TBC	Supply Contractor	Supply Contractor			WC-P0005			
0007	O	LS-C020B	Level Switch	Filter Polymer Bulk Powder Screw Feeder Blocked			120V		TBC	Supply Contractor	Supply Contractor			WC-P0005			
0008	O	WE-C020A	Load Cells	Filter Polymer Bulk Powder Weight										WC-P0005			
0009	O	WT-C020A	Weight Indicator Transmitter	Filter Polymer Bulk Powder Weight										WC-P0005			
0010	O	LS-C021A	Level Switch	Filter Polymer Preparation Tank High			120V		TBC	Supply Contractor	Supply Contractor			WC-P0006			
0011	O	LS-C021B	Level Switch	Filter Polymer Preparation Tank Low			120V		TBC	Supply Contractor	Supply Contractor			WC-P0006			
0012	O	SOL-C021B	Solenoid Actuator	Filter Polymer Preparation Tank Service Water Inlet Valve										WC-P0006			
0013	O	LE-C022A	Level Element	Filter Polymer Feed Tank Level					Flange	E&I Contractor	E&I Contractor		I120	WC-P0008	WB-A0455	WB-A0401	NOD
0014	O	LT-C022A	Level Indicator Transmitter	Filter Polymer Feed Tank Level			120V	TBC	Wall/ Stand	Mech Contractor	E&I Contractor		I120	WC-P0008	WB-A0455	WB-A0402	NOD
0015	O	LI-C022B	Bypass Level Indicator	Filter Polymer Feed Tank Level										WC-P0008			
0016	O	LS-C030A	Level Switch	Sludge Polymer Bulk Powder Unloading Hopper Low			120V		TBC	Supply Contractor	Supply Contractor			WC-P0005			
0017	O	LS-C030B	Level Switch	Sludge Polymer Bulk Powder Screw Feeder Blocked			120V		TBC	Supply Contractor	Supply Contractor			WC-P0005			
0018	O	WE-C030A	Load Cells	Sludge Polymer Bulk Powder Weight										WC-P0005			
0019	O	WT-C030A	Weight Indicator Transmitter	Sludge Polymer Bulk Powder Weight										WC-P0005			
0020	O	LS-C031A	Level Switch	Sludge Polymer Preparation Tank High			120V		TBC	Supply Contractor	Supply Contractor			WC-P0007			
0021	O	LS-C031B	Level Switch	Sludge Polymer Preparation Tank Low			120V		TBC	Supply Contractor	Supply Contractor			WC-P0007			
0022	O	SOL-C031B	Solenoid Actuator	Sludge Polymer Preparation Tank Service Water Inlet Valve										WC-P0007			
0023	O	LE-C032A	Level Element	Sludge Polymer Feed Tank Level					Flange	E&I Contractor	E&I Contractor		I120	WC-P0009	WB-A0455	WB-A0401	NOD
0024	O	LT-C032A	Level Indicator Transmitter	Sludge Polymer Feed Tank Level			120V	TBC	Wall/ Stand	Mech Contractor	E&I Contractor		I120	WC-P0009	WB-A0455	WB-A0402	NOD
0025	O	LI-C032B	Bypass Level Indicator	Sludge Polymer Feed Tank Level										WC-P0009			
0026	O	FE-C061A	Flow Element	Filter Polymer Feed Pump P-C061A Discharge Flow					Flange	Mech. Contractor	Mech. Contractor	25mm	I100	WC-P0014	WB-A0453	WB-A0453	WC-E0112
0027	O	FT-C061A	Flow Indicator Transmitter	Filter Polymer Feed Pump P-C061A Discharge Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WC-P0014	WB-A0453	WB-A0402	WC-E0112
0028	O	FS-C061A	Flow Switch	Service Water to PC061A Low Flow										WC-P0014			
0029	O	FI-C061A	Flow Indicator	Service Water to PC061A Discharge Flow										WC-P0014			
0030	O	PI-C061A	Pressure Indicator	Filter Polymer Feed Pump PC061A Discharge Pressure									I112	WC-P0014			
0031	O	SOL-C061A	Solenoid Valve	Service Water to PC061A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0014			
0032	O	TS-C061A	Temperature Switch	Filter Polymer Feed Pump PC061A High Stator Temperature										WC-P0014			
0033	O	FE-C062A	Flow Element	Filter Polymer Feed Pump P-C062A Discharge Flow					Flange	Mech. Contractor	Mech. Contractor	25mm	I100	WC-P0014	WB-A0453	WB-A0453	WC-E0112
0034	O	FT-C062A	Flow Indicator Transmitter	Filter Polymer Feed Pump P-C062A Discharge Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WC-P0014	WB-A0453	WB-A0402	WC-E0112
0035	O	FS-C062A	Flow Switch	Service Water to PC062A Low Flow										WC-P0014			
0036	O	FI-C062A	Flow Indicator	Service Water to PC062A Discharge Flow										WC-P0014			
0037	O	PI-C062A	Pressure Indicator	Filter Polymer Feed Pump PC062A Discharge Pressure									I112	WC-P0014			
0038	O	SOL-C062A	Solenoid Valve	Service Water to PC062A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0014			
0039	O	TS-C062A	Temperature Switch	Filter Polymer Feed Pump PC062A High Stator Temperature										WC-P0014			
0040	O	FE-C063A	Flow Element	Filter Polymer Feed Pump P-C063A Discharge Flow					Flange	Mech. Contractor	Mech. Contractor	25mm	I100	WC-P0014	WB-A0453	WB-A0453	WC-E0112
0041	O	FT-C063A	Flow Indicator Transmitter	Filter Polymer Feed Pump P-C063A Discharge Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WC-P0014	WB-A0453	WB-A0402	WC-E0112
0042	O	FS-C063A	Flow Switch	Service Water to PC063A Low Flow										WC-P0014			
0043	O	FI-C063A	Flow Indicator	Service Water to PC063A Discharge Flow										WC-P0014			
0044	O	PI-C063A	Pressure Indicator	Filter Polymer Feed Pump PC063A Discharge Pressure									I112	WC-P0014			
0045	O	SOL-C063A	Solenoid Valve	Service Water to PC063A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0014			
0046	O	TS-C063A	Temperature Switch	Filter Polymer Feed Pump PC063A High Stator Temperature										WC-P0014			
0047	O	FE-C071A	Flow Element	Sludge Polymer Feed Pump P-C071A Discharge Flow					Flange	Mech. Contractor	Mech. Contractor	25mm	I100	WC-P0015	WB-A0453	WB-A0453	WC-E0112
0048	O	FT-C071A	Flow Indicator Transmitter	Sludge Polymer Feed Pump P-C071A Discharge Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WC-P0015	WB-A0453	WB-A0402	WC-E0112
0049	O	FS-C071A	Flow Switch	Service Water to PC071A Low Flow										WC-P0015			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0050	O	FI-C071A	Flow Indicator	Service Water to PC071A Discharge Flow										WC-P0015			
0051	O	PI-C071A	Pressure Indicator	Sludge Polymer Feed Pump PC071A Discharge Pressure									I112	WC-P0015			
0052	O	SOL-C071A	Solenoid Valve	Service Water to P-C071A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0015			
0053	O	TS-C071A	Temperature Switch	Sludge Polymer Feed Pump PC071A High Stator Temperature										WC-P0015			
0054	O	FE-C072A	Flow Element	Sludge Polymer Feed Pump P-C072A Discharge Flow					Flange	Mech. Contractor	Mech. Contractor	25mm	I100	WC-P0015	WB-A0453	WB-A0453	WC-E0112
0055	O	FT-C072A	Flow Indicator Transmitter	Sludge Polymer Feed Pump P-C072A Discharge Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WC-P0015	WB-A0453	WB-A0402	WC-E0112
0056	O	FS-C072A	Flow Switch	Service Water to PC072A Low Flow										WC-P0015			
0057	O	FI-C072A	Flow Indicator	Service Water to PC072A Discharge Flow										WC-P0015			
0058	O	PI-C072A	Pressure Indicator	Sludge Polymer Feed Pump PC072A Discharge Pressure									I112	WC-P0015			
0059	O	SOL-C072A	Solenoid Valve	Service Water to P-C072A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0015			
0060	O	TS-C072A	Temperature Switch	Sludge Polymer Feed Pump PC072A High Stator Temperature										WC-P0015			
0061	O	LE-C701A	Level Element	Filter Inlet Chamber (TK-C701A) Level					Flange	E&I Contractor	E&I Contractor		I120	WO-P0010	WB-A0455	WB-A0401	NOD
0062	O	LT-C701A	Level Indicator Transmitter	Filter Inlet Chamber (TK-C701A) Level			120V	0-5 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WO-P0010	WB-A0455	WB-A0402	NOD
0063	O	LE-C702A	Level Element	Filter Inlet Chamber (TK-C702A) Level					Flange	E&I Contractor	E&I Contractor		I120	WO-P0011	WB-A0455	WB-A0401	NOD
0064	O	LT-C702A	Level Indicator Transmitter	Filter Inlet Chamber (TK-C702A) Level			120V	0-5 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WO-P0011	WB-A0455	WB-A0402	NOD
0065	O	LS-C800A	Conductivity Level Switch	Hydrogen Peroxide Spill Containment High Level			120V	6mm from floor of containment	Bracket	E&I Contractor	E&I Contractor	To measure any liquid in containment	I126	WC-P0001	WB-A0458	N/A	NOD
0066	O	LE-C810A	Level Element	Hydrogen Peroxide Feed Tank TKC810A Level					Flange	E&I Contractor	E&I Contractor		I120	WC-P0001	WB-A0455	WB-A0401	NOD
0067	O	LT-C810A	Level Indicator Transmitter	Hydrogen Peroxide Feed Tank TKC810A Level			120V	0-4 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WC-P0001	WB-A0455	WB-A0402	NOD
0068	O	LI-C810B	Remote Indicator	Hydrogen Peroxide Feed Tank TKC810A Level										WC-P0001			
0069	O	LI-C810A	Level Indicator	Hydrogen Peroxide Feed Tank TKC810A Sight Glass										WC-P0001			
0070	O	LE-C820A	Level Element	Hydrogen Peroxide Feed Tank TKC820A Level					Flange	E&I Contractor	E&I Contractor		I120	WC-P0001	WB-A0455	WB-A0401	NOD
0071	O	LT-C820A	Level Indicator Transmitter	Hydrogen Peroxide Feed Tank TKC820A Level			120V	0-4 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WC-P0001	WB-A0455	WB-A0402	NOD
0072	O	LI-C820A	Remote Indicator	Hydrogen Peroxide Feed Tank TKC820A Level										WC-P0001			
0073	O	LI-C820A	Level Indicator	Hydrogen Peroxide Feed Tank TKC820A Sight Glass										WC-P0001			
0074		FT-C840A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C840A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0002	WB-A0456		
0075	O	FI-C840A	Flow Indicator	Service Water to PC840A Flow Indicator										WC-P0002			
0076	O	FS-C840A	Flow Switch	Service Water to PC840A Low Flow										WC-P0002			
0077	O	PI-C840A	Pressure Indicator	Hydrogen Peroxide Dosing Pump PC840A Outlet Pressure								To measure any liquid in containment	I112	WC-P0002			
0078	O	SOL-C840A	Solenoid Valve	Service Water to PC840A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0002			
0079		FT-C850A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C850A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0002	WB-A0456		
0080	O	FI-C850A	Flow Indicator	Service Water to PC850A Flow Indicator										WC-P0002			
0081	O	FS-C850A	Flow Switch	Service Water to PC850A Low Flow										WC-P0002			
0082	O	PI-C850A	Pressure Indicator	Hydrogen Peroxide Dosing Pump PC850A Outlet Pressure									I112	WC-P0002			
0083	O	SOL-C850A	Solenoid Valve	Service Water to PC850A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0002			
0084		FT-C860A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C860A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0002	WB-A0456		
0085	O	FI-C860A	Flow Indicator	Service Water to PC860A Flow Indicator										WC-P0002			
0086	O	FS-C860A	Flow Switch	Service Water to PC860A Low Flow										WC-P0002			
0087	O	PI-C860A	Pressure Indicator	Hydrogen Peroxide Dosing Pump PC860A Outlet Pressure									I112	WC-P0002			
0088	O	SOL-C860A	Solenoid Valve	Service Water to PC860A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0002			
0089	O	LE-C940B	Level Element	Sodium Bisulphite Feed Tank Level					Flange	E&I Contractor	E&I Contractor	To measure any liquid in containment	I120	WC-P0003	WB-A0455	WB-A0401	NOD
0090	O	LT-C940B	Level Indicator Transmitter	Sodium Bisulphite Feed Tank Level			120V	0-1.8 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WC-P0003	WB-A0455	WB-A0402	NOD
0091		FT-C950A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C950A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0004	WB-A0456		
0092	O	PI-C950A	Pressure Indicator	Sodium Bisulphite Pump PC950A Outlet Pressure Indicator									I112	WC-P0004			
0093		SOL-C950A	Solenoid Valve	Service Water to P-C950A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0004			
0094		FT-C960A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C960A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0004	WB-A0456		
0095	O	PI-C960A	Pressure Indicator	Sodium Bisulphite Pump PC960A Outlet Pressure Indicator									I112	WC-P0004			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0096		SOL-C960A	Solenoid Valve	Service Water to P-C960A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0004			
0097		FT-C970A	Flow Indicator Transmitter	Hydrogen Peroxide Metering Pump P-C970A Outlet Flow Rate			24V DC		Inline	Mech. Contractor	Mech. Contractor	Compact 6mm Inline flow meter	I102	WC-P0004	WB-A0456		
0098	O	PI-C970A	Pressure Indicator	Sodium Bisulphite Pump PC970 Outlet Pressure Indicator									I112	WC-P0004			
0099		SOL-C970A	Solenoid Valve	Service Water to P-C970A Discharge Flow Control Valve						Mech. Contractor	Mech. Contractor			WC-P0004			
0100	O	LS-C980A	Conductivity Level Switch	Sodium Bisulphite Spill Containment High Level			120V	6mm from floor of containment	Bracket	E&I Contractor	E&I Contractor	To measure any liquid in containment	I126	WC-P0003	WB-A0458	N/A	NOD
0101	O	PT-F010A	Pressure Indicator Transmitter	Filter Air Scour Blower BLWF010A Inlet Air Filter Differential Pressure			Loop Powered	0-100 Kpa	Manifold	E&I Contractor	Mech. Contractor		I111	WF-P0010	WB-A0465		WF-M0406
0102	O	PI-F010A	Pressure Indicator	Filter Air Scour Blower BLWF010A Outlet Air Pressure									I112	WF-P0010			WF-M0406
0103	O	PT-F010B	Pressure Indicator Transmitter	Filter Air Scour Blower BLWF010A Outlet Air Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I111	WF-P0010	WB-A0465		
0104	O	TT-F010A	Temperature Indicator Transmitter (RTD)	Filter Air Scour Blower BLWF010A Winding Temperature									I131	WF-P0010			WF-M0406
0105	O	TT-F010B	Temperature Indicator Transmitter (RTD)	Filter Air Scour Blower BLWF010A Bearing Temperature									I131	WF-P0010			
0106	O	TT-F010A	Temperature Indicator	Filter Air Scour Blower BLWF010A Outlet Air Temperature									I131	WF-P0010			WF-M0406
0107	O	VT-F010A	Vibration Transmitter	Filter Air Scour Blower BLWF010A Vibration Monitor										WF-P0010			WF-M0406
0108	O	PT-F020A	Pressure Indicator Transmitter	Filter Air Scour Blower BLWF020A Inlet Air Filter Differential Pressure			Loop Powered	0-100 Kpa	Manifold	E&I Contractor	Mech. Contractor		I111	WF-P0010	WB-A0465		WF-M0406
0109	O	PI-F020A	Pressure Indicator	Filter Air Scour Blower BLWF020A Outlet Air Pressure									I112	WF-P0010			WF-M0406
0110	O	PT-F020B	Pressure Indicator Transmitter	Filter Air Scour Blower BLWF020A Outlet Air Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I111	WF-P0010	WB-A0465		
0111	O	TT-F020A	Temperature Indicator Transmitter (RTD)	Filter Air Scour Blower BLWF020A Winding Temperature									I131	WF-P0010			WF-M0406
0112	O	TT-F020B	Temperature Indicator Transmitter (RTD)	Filter Air Scour Blower BLWF020A Bearing Temperature									I131	WF-P0010			
0113	O	TT-F020A	Temperature Indicator	Filter Air Scour Blower BLWF020A Outlet Air Temperature				0-180 Kpa					I131	WF-P0010			WF-M0406
0114	O	VT-F020A	Vibration Transmitter	Filter Air Scour Blower BLWF020A High Vibration										WF-P0010			WF-M0406
0115	O	FE-F030A	Flow Element	Filter Air Scour Blower Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	350mm V cone flowmeter		WF-P0010			WF-M0406
0116	O	FT-F030A	Flow Indicator Transmitter	Filter Air Scour Blower Outlet Flow			Loop Powered		Wall/Stand	Mech. Contractor	E&I Contractor	Differential pressure transmitter with temp compensation		WF-P0010	WB-A0465		WF-M0406
0117	O	TT-F030A	Temperature Indicator Transmitter	Filter Air Scour Blower Outlet Temperature									I131	WF-P0010			WF-M0406
0118	O	LT-F050A	Level Indicator Transmitter	Filtered Water Chamber Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0011	WB-A0455	WB-A0402	NOD
0119	O	LE-F050A	Level Element	Filtered Water Chamber Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0011	WB-A0455	WB-A0401	NOD
0120	O	FS-F055A	Flow Switch	Chlorine Contact Tank to Supernatent Pump Station Drain Pump Outlet Flow										WF-P0012			WF-M0407
0121	O	AE-F056A	Free Chlorine Analyzer	Chlorine Contact Tank Outlet Free Chlorine Measurement										WF-P0011			
0122	O	AT-F056A	Free Chlorine Analyzer	Chlorine Contact Tank Outlet Free Chlorine Measurement										WF-P0011			
0123	O	FI-F056A	Flow Indicator	Chlorine Contact Tank Outlet Free Chlorine Sample Flow										WF-P0011			
0124	O	FS-F056A	Flow Switch	Chlorine Contact Tank Outlet Free Chlorine Sample Flow Low										WF-P0011			
0125	O	LT-F100A	Level Indicator Transmitter	Filter No. 1 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0001	WB-A0455	WB-A0402	NOD
0126	O	LE-F100A	Level Element	Filter No. 1 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0001	WB-A0455	WB-A0401	NOD
0127	O	PT-F100A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Flange	E&I Contractor	Mech. Contractor		I110	WF-P0001	WB-A0465	WF-M0451	WF-M0451
0128	O	PI-F100B	Differential Pressure Indicator	Top Filter Media Differential Pressure									I110	WF-P0001			WF-M0407
0129	O	PI-F100C	Differential Pressure Indicator	Bottom Filter Media Differential Pressure									I110	WF-P0001			
0130	O	FT-F103A	Flow Indicator Transmitter	Filter TKF100A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0001	WB-A0453	WB-A0402	WF-E0103
0131	O	FE-F103A	Flow Element	Filter TKF100A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0001	WB-A0453	WB-A0453	WF-M0401
0132	O	AT-F110A	Turbidity Analyzer/ Transmitter	Filter TKF100A Outlet Turbidity										WF-P0001			
0133	O	AT-F110B	Particle Counter Transmitter	Filter TKF100A Outlet Particle Count										WF-P0001			
0134	O	FI-F110A	Flow Indicator	Filter TKF100A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0001			
0135	O	FI-F110B	Flow Indicator	Filter TKF100A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0001			
0136	O	LT-F200A	Level Indicator Transmitter	Filter No. 2 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0002	WB-A0455	WB-A0402	NOD

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0137	O	LE-F200A	Level Element	Filter No. 2 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0002	WB-A0455	WB-A0401	NOD
0138	O	PT-F200A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0002	WB-A0465	WF-M0451	
0139	O	FT-F203A	Flow Indicator Transmitter	Filter TKF200A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0002	WB-A0453	WB-A0402	WF-E0103
0140	O	FE-F203A	Flow Element	Filter TKF200A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0002	WB-A0453	WB-A0453	WF-M0402
0141	O	AT-F210A	Turbidity Analyzer/ Transmitter	Filter TKF200A Outlet Turbidity										WF-P0002			
0142	O	AT-F210B	Particle Counter Transmitter	Filter TKF200A Outlet Particle Count										WF-P0002			
0143	O	FI-F210A	Flow Indicator	Filter TKF200A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0002			
0144	O	FI-F210B	Flow Indicator	Filter TKF200A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0002			
0145	O	LT-F300A	Level Indicator Transmitter	Filter No. 3 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0003	WB-A0455	WB-A0402	NOD
0146	O	LE-F300A	Level Element	Filter No. 3 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0003	WB-A0455	WB-A0401	NOD
0147	O	PT-F300A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0003	WB-A0465	WF-M0451	
0148	O	FT-F303A	Flow Indicator Transmitter	Filter TKF300A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0003	WB-A0453	WB-A0402	WF-E0103
0149	O	FE-F303A	Flow Element	Filter TKF300A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0003	WB-A0453	WB-A0453	WF-M0402
0150	O	AT-F310A	Turbidity Analyzer/ Transmitter	Filter TKF300A Outlet Turbidity										WF-P0003			
0151	O	AT-F310B	Particle Counter Transmitter	Filter TKF300A Outlet Particle Count										WF-P0003			
0152	O	FI-F310A	Flow Indicator	Filter TKF300A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0003			
0153	O	FI-F310B	Flow Indicator	Filter TKF300A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0003			
0154	O	LT-F400A	Level Indicator Transmitter	Filter No. 4 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0004	WB-A0455	WB-A0402	NOD
0155	O	LE-F400A	Level Element	Filter No. 4 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0004	WB-A0455	WB-A0401	NOD
0156	O	PT-F400A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0004	WB-A0465	WF-M0451	
0157	O	FT-F403A	Flow Indicator Transmitter	Filter TKF400A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0004	WB-A0453	WB-A0402	WF-E0103
0158	O	FE-F403A	Flow Element	Filter TKF400A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0004	WB-A0453	WB-A0453	WF-M0403
0159	O	AT-F410A	Turbidity Analyzer/ Transmitter	Filter TKF400A Outlet Turbidity										WF-P0004			
0160	O	AT-F410B	Particle Counter Transmitter	Filter TKF400A Outlet Particle Count										WF-P0004			
0161	O	FI-F410A	Flow Indicator	Filter TKF400A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0004			
0162	O	FI-F410B	Flow Indicator	Filter TKF400A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0004			
0163	O	LT-F500A	Level Indicator Transmitter	Filter No. 5 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0005	WB-A0455	WB-A0402	NOD
0164	O	LE-F500A	Level Element	Filter No. 5 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0005	WB-A0455	WB-A0401	NOD
0165	O	PT-F500A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0005	WB-A0465	WF-M0451	
0166	O	FT-F503A	Flow Indicator Transmitter	Filter TKF500A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0005	WB-A0453	WB-A0402	WF-E0104
0167	O	FE-F503A	Flow Element	Filter TKF500A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0005	WB-A0453	WB-A0453	WF-M0403
0168	O	AT-F510A	Turbidity Analyzer/ Transmitter	Filter TKF500A Outlet Turbidity										WF-P0005			
0169	O	AT-F510B	Particle Counter Transmitter	Filter TKF500A Outlet Particle Count										WF-P0005			
0170	O	FI-F510A	Flow Indicator	Filter TKF500A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0005			
0171	O	FI-F510B	Flow Indicator	Filter TKF500A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0005			
0172	O	LT-F600A	Level Indicator Transmitter	Filter No. 6 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0006	WB-A0455	WB-A0402	NOD
0173	O	LE-F600A	Level Element	Filter No. 6 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0006	WB-A0455	WB-A0401	NOD
0174	O	PT-F600A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0006	WB-A0465	WF-M0451	
0175	O	FT-F603A	Flow Indicator Transmitter	Filter TKF600A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0006	WB-A0453	WB-A0402	WF-E0104
0176	O	FE-F603A	Flow Element	Filter TKF600A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0006	WB-A0453	WB-A0453	WF-M0403
0177	O	AT-F610A	Turbidity Analyzer/ Transmitter	Filter TKF600A Outlet Turbidity										WF-P0006			
0178	O	AT-F610B	Particle Counter Transmitter	Filter TKF600A Outlet Particle Count										WF-P0006			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0179	O	FI-F610A	Flow Indicator	Filter TKF600A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0006			
0180	O	FI-F610B	Flow Indicator	Filter TKF600A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0006			
0181	O	LT-F700A	Level Indicator Transmitter	Filter No. 7 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0007	WB-A0455	WB-A0402	NOD
0182	O	LE-F700A	Level Element	Filter No. 7 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0007	WB-A0455	WB-A0401	NOD
0183	O	PT-F700A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0007	WB-A0465	WF-M0451	
0184	O	FT-F703A	Flow Indicator Transmitter	Filter TKF700A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0007	WB-A0453	WB-A0402	WF-E0104
0185	O	FE-F703A	Flow Element	Filter TKF700A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0007	WB-A0453	WB-A0453	WF-M0404
0186	O	AT-F710A	Turbidity Analyzer/ Transmitter	Filter TKF700A Outlet Turbidity										WF-P0007			
0187	O	AT-F710B	Particle Counter Transmitter	Filter TKF700A Outlet Particle Count										WF-P0007			
0188	O	FI-F710A	Flow Indicator	Filter TKF700A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0007			
0189	O	FI-F710B	Flow Indicator	Filter TKF700A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0007			
0190	O	LT-F800A	Level Indicator Transmitter	Filter No. 8 Level			120V	0-10 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0008	WB-A0455	WB-A0402	NOD
0191	O	LE-F800A	Level Element	Filter No. 8 Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0008	WB-A0455	WB-A0401	NOD
0192	O	PT-F800A	Differential Pressure Indicator Transmitter	Overall Filter Differential Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I110	WF-P0008	WB-A0465	WF-M0451	
0193	O	PI-F800B	Differential Pressure Indicator	Top Filter Media Differential Pressure									I110	WF-P0008			
0194	O	PI-F800C	Differential Pressure Indicator	Bottom Filter Media Differential Pressure									I110	WF-P0008			
0195	O	FT-F803A	Flow Indicator Transmitter	Filter TKF800A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0008	WB-A0453	WB-A0402	WF-E0104
0196	O	FE-F803A	Flow Element	Filter TKF800A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0008	WB-A0453	WB-A0453	WF-M0404
0197	O	AT-F810A	Turbidity Analyzer/ Transmitter	Filter TKF800A Outlet Turbidity										WF-P0008			
0198	O	AT-F810B	Particle Counter Transmitter	Filter TKF800A Outlet Particle Count										WF-P0008			
0199	O	FI-F810A	Flow Indicator	Filter TKF800A Outlet Turbidity Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0008			
0200	O	FI-F810B	Flow Indicator	Filter TKF800A Outlet Particle Counter Sample Flow Low								Rotameter Complete With Low Flow Switch		WF-P0008			
0201	O	PT-F910A	Pressure Indicator/Level Transmitter	Backwash Tank TNKF910A Level			Loop Powered	0-180 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WF-P0009	WB-A0465	WB-A0408	
0202	O	FT-F911A	Flow Indicator Transmitter	Filter Backwash Pump P-F911A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0009	WB-A0453	WB-A0402	WF-E0103
0203	O	FE-F911A	Flow Element	Filter Backwash Pump P-F911A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0009	WB-A0453	WB-A0453	WF-E0103
0204	O	PI-F911A	Pressure Indicator	Filter Backwash Pump P-F911A Outlet Pressure									I112	WF-P0009			
0205	O	PS-F911A	Pressure Switch	Filter Backwash Pump P-F911A High Outlet Pressure									I115	WF-P0009			
0206	O	PT-F911A	Pressure Indicator Transmitter	Filter Backwash Pump P-F911A Outlet Pressure			Loop Powered	0-180 Kpa	Gauge Valve	E&I Contractor	Mech. Contractor		I111	WF-P0009	WB-A0465		
0207	O	TT-F911A	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0208	O	TT-F911B	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0209	O	TT-F911C	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0210	O	TT-F911D	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0211	O	TT-F911E	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0212	O	TT-F911F	Temperature Transmitter	Filter Backwash Pump P-F911A Winding Temperature									I131	WF-P0013			
0213	O	TT-F911G	Temperature Transmitter	Filter Backwash Pump P-F911A Front Bearing Temperature									I131	WF-P0013			
0214	O	TT-F911H	Temperature Transmitter	Filter Backwash Pump P-F911A Back Bearing Temperature									I131	WF-P0013			
0215	O	TT-F911A	Temperature Indicator Transmitter	Filter Backwash Pump P-F911A Outlet Temperature									I131	WF-P0009			
0216	O	TE-F911A	Temperature Element	Filter Backwash Pump P-F911A Outlet Temperature									I131	WF-P0009			
0217	O	VT-F911A	Vibration Transmitter	Filter Backwash Pump P-F911A Vibration										WF-P0013			
0218	O	PT-F920A	Pressure Indicator/Level Transmitter	Backwash Tank TNKF920A Level			Loop Powered	0-180 Kpa	Flange	E&I Contractor	Mech. Contractor		I120	WF-P0009	WB-A0465	WB-A0408	
0219	O	FT-F921A	Flow Indicator Transmitter	Filter Backwash Pump P-F921A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0009	WB-A0453	WB-A0402	WF-E0104
0220	O	FE-F921A	Flow Element	Filter Backwash Pump P-F921A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	600 mm	I100	WF-P0009	WB-A0453	WB-A0453	WF-E0104
0221	O	PI-F921A	Pressure Indicator	Filter Backwash Pump P-F921A Outlet Pressure									I112	WF-P0009			
0222	O	PS-F921A	Pressure Switch	Filter Backwash Pump P-F921A High Outlet Pressure									I115	WF-P0009			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0223	O	PT-F921A	Pressure Indicator Transmitter	Filter Backwash Pump P-F921A Outlet Pressure			Loop Powered	0-180 Kpa	Manifold	E&I Contractor	Mech. Contractor		I111	WF-P0009	WB-A0465		
0224	O	TT-F921A	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0225	O	TT-F921B	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0226	O	TT-F921C	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0227	O	TT-F921D	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0228	O	TT-F921E	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0229	O	TT-F921F	Temperature Transmitter	Filter Backwash Pump P-F921A Winding Temperature									I131	WF-P0013			
0230	O	TT-F921G	Temperature Transmitter	Filter Backwash Pump P-F921A Front Bearing Temperature									I131	WF-P0013			
0231	O	TT-F921H	Temperature Transmitter	Filter Backwash Pump P-F921A Back Bearing Temperature									I131	WF-P0013			
0232	O	TT-F921A	Temperature Indicator Transmitter	Filter Backwash Pump P-F921 Outlet Temperature									I131	WF-P0009			
0233	O	TE-F921A	Temperature Element	Filter Backwash Pump P-F921 Outlet Temperature									I131	WF-P0009			
0234	O	VT-F921A	Vibration Transmitter	Filter Backwash Pump P-F921A Vibration										WF-P0013			
0235	O	LE-F980A	Level Element	Backwash Area Process Sump Pump Level					Flange	E&I Contractor	E&I Contractor	Mounted above grating	I120	WF-P0012	WB-A0455	WB-A0401	WF-E0104
0236	O	LT-F980A	Level Indicator Transmitter	Backwash Area Process Sump Pump Level			120V	0-3 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0012	WB-A0455	WB-A0402	WF-E0104
0237	O	LE-F980B	Level Element	Backwash Area Process Sump Pump Level					Flange	E&I Contractor	E&I Contractor		I120	WF-P0012	WB-A0455	WB-A0401	WF-E0104
0238	O	LT-F980B	Level Indicator Transmitter	Backwash Area Process Sump Pump Level			120V	0-3 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WF-P0012	WB-A0455	WB-A0402	WF-E0104
0239	O	LS-F984A	Conductivity Level Switch	Backwash Area Process Sump Pump P-F984A Stop Level			120V		Flange	E&I Contractor	E&I Contractor		I126	WF-P0012	WB-A0458	N/A	WF-E0104
0240	O	LS-F984B	Conductivity Level Switch	Backwash Area Process Sump Pump P-F984A Start Level			120V		Flange	E&I Contractor	E&I Contractor		I126	WF-P0012	WB-A0458	N/A	WF-E0104
0241		FS-H120A	Flow Switch	Sprinkler and Standpipes Fire Pump Outlet Flow										WH-P0008			
0242		FS-H130A	Flow Switch	Outdoor Hydrant Emergency Pump Outlet Flow										WH-P0008			
0243	O	FE-H153A	Flow Element	Fire Pump Test Line Flow								200 mm	I100	WH-P0006			
0244	O	FT-H153A	Flow Indicator Transmitter	Fire Pump Test Line Flow					Wall/Stand				I100	WH-P0006	WB-A0465		
0245		LE-H400A	Level Element	Fire Pump Room Process Sump Level						E&I Contractor	E&I Contractor		I120	WH-P0007	WB-A0455	WB-A0401	
0246		LT-H400A	Level Indicator Transmitter	Fire Pump Room Process Sump Level			120V	0-2 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WH-P0007	WB-A0455	WB-A0402	
0247		LE-H400B	Level Element	Fire Pump Room Process Sump Level						E&I Contractor	E&I Contractor		I120	WH-P0007	WB-A0455	WB-A0401	
0248		LT-H400B	Level Indicator Transmitter	Fire Pump Room Process Sump Level			120V	0-2 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WH-P0007	WB-A0455	WB-A0402	
0249	O	LS-H500A	Level Switch	Fire Pump Room Sanitary Sump Low Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0001	WB-A0463	WB-A0406	
0250	O	LS-H500B	Level Switch	Fire Pump Room Sanitary Sump Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0001	WB-A0463	WB-A0406	
0251	O	LS-H500C	Level Switch	Fire Pump Room Sanitary Sump High High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0001	WB-A0463	WB-A0406	
0252		LS-H500D	Level Switch	Fire Pump Room Sanitary Sump High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0001	WB-A0463	WB-A0406	
0253	O	LS-H510A	Level Switch	Backwash Pump Gallery Sanitary Sump Low Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0002	WB-A0463	WB-A0406	
0254	O	LS-H510B	Level Switch	Backwash Pump Gallery Sanitary Sump Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0002	WB-A0463	WB-A0406	
0255	O	LS-H510C	Level Switch	Backwash Pump Gallery Sanitary Sump High High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0002	WB-A0463	WB-A0406	
0256		LS-H510D	Level Switch	Backwash Pump Gallery Sanitary Sump High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0002	WB-A0463	WB-A0406	
0257	O	LS-H520A	Level Switch	Elevator Pit Sanitary Sump Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0003	WB-A0463	WB-A0406	
0258	O	LS-H520B	Level Switch	Elevator Pit Sanitary Sump High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0003	WB-A0463	WB-A0406	
0259	O	LS-H530A	Level Switch	Admin Area Sanitary Sump Low Low Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0004	WB-A0463	WB-A0406	
0260	O	LS-H530B	Level Switch	Admin Area Sanitary Sump High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0004	WB-A0463	WB-A0406	
0261	O	LS-H530C	Level Switch	Admin Area Sanitary Sump High High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0004	WB-A0463	WB-A0406	
0262		LS-H530D	Level Switch	Admin Area Sanitary Sump High Level Switch			120V			E&I Contractor	E&I Contractor	Wired to local control panel	I125	WH-P0004	WB-A0463	WB-A0406	
0263		PS-H601A	Pressure Switch	Wet Air Receiver PV-H601A High Pressure										WH-P0008			
0264		PS-H601B	Pressure Switch	Wet Air Receiver PV-H601B Low Pressure										WH-P0008			
0265		PS-H602A	Pressure Switch	Wet Air Receiver PV-H602A High Pressure										WH-P0008			
0266		PS-H602B	Pressure Switch	Wet Air Receiver PV-H602B Low Pressure										WH-P0008			
0267		PS-H605A	Pressure Switch	Dry Air Receiver PV-H605A High Pressure										WH-P0008			
0268		PS-H605B	Pressure Switch	Dry Air Receiver PV-H605A Low Pressure										WH-P0008			
0269	O	PT-H701A	Pressure Indicator Transmitter	Potable Water to Clearwell Area Pressure			Loop Powered	0-500 Kpa	Gauge Valve	E&I Contractor	E&I Contractor		I111	WH-P0005	WB-A0465		
0270	O	PT-H704A	Pressure Indicator Transmitter	Potable Water to Water Treatment Plant Pressure			Loop Powered	0-500 Kpa	Gauge Valve	E&I Contractor	E&I Contractor		I111	WH-P0005	WB-A0465		
0271	O	LT-I000A	Level Indicator Transmitter	Raw Water Pumping Station Level			120V	0-12 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WI-P0001	WB-A0455	WB-A0402	WI-M0132
0272	O	LE-I000A	Level Element	Raw Water Pumping Station Level					Flange	E&I Contractor	E&I Contractor		I120	WI-P0001	WB-A0455	WB-A0401	WI-E0132
0273	O	LE-I000B	Level Element	Raw Water Pumping Station Level					Flange	E&I Contractor	E&I Contractor		I120	WI-P0002	WB-A0455	WB-A0401	WI-E0132

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0274	O	LT-I000B	Level Indicator Transmitter	Raw Water Pumping Station Level			120V	0-12 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WI-P0002	WB-A0455	WB-A0402	WI-M0132
0275	O	LS-I000A	Level Switch	Raw Water Pumping Station Low Low Level			120V	3 mtrs	Bracket	E&I Contractor	E&I Contractor	Measured from floor of well	I125	WI-P0001	WB-A0463	WB-A0406	WI-M0132
0276	O	LS-I000B	Level Switch	Raw Water Pumping Station Low Low Level			120V	3 mtrs	Bracket	E&I Contractor	E&I Contractor	Measured from floor of well	I125	WI-P0002	WB-A0463	WB-A0406	WI-M0132
0277	O	LS-I000C	Level Switch	Raw Water Pumping Station High High Level			120V	12.4 mtrs	Bracket	E&I Contractor	E&I Contractor	Measured from floor of well	I125	WI-P0001	WB-A0463	WB-A0406	WI-M0132
0278	O	LS-I000D	Level Switch	Raw Water Pumping Station High High Level			120V	12.4 mtrs	Bracket	E&I Contractor	E&I Contractor	Measured from floor of well	I125	WI-P0002	WB-A0463	WB-A0406	WI-M0132
0279	O	PI-I001A	Pressure Indicator	Raw Water Pump P-I001A Outlet Pressure				0-200Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0001		WB-A0404	
0280		PI-I001B	Pressure Indicator	Raw Water Pump P-I001A Outlet Pressure				0-300Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0001		WB-A0404	
0281	O	ST-I001A	Speed Indicator Transmitter	Raw Water Pump P-I001A Speed Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0003			
0282	O	TE-I001A	Temperature Element	Raw Water Pump P-I001A Top Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0283	O	TE-I001B	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0284	O	TE-I001C	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0285	O	TE-I001D	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0286	O	TE-I001E	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0287	O	TE-I001F	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0288	O	TE-I001G	Temperature Element	Raw Water Pump P-I001A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0289	O	TE-I001H	Temperature Element	Raw Water Pump P-I001A Bottom Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0290		TE-I001I	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0003	WB-A0466		
0291		TT-I001I	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0003			
0292		TE-I001J	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0003			
0293		TT-I001J	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0003			
0294	O	VT-I001A	Vibration Indication Transmitter	Raw Water Pump P-I001A Vibration Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0003			
0295	O	PI-I002A	Pressure Indicator	Raw Water Pump P-I002A Outlet Pressure				0-200Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0001		WB-A0404	
0296		PI-I002B	Pressure Indicator	Raw Water Pump P-I002A Outlet Pressure				0-300Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0001		WB-A0404	
0297	O	ST-I002A	Speed Indicator Transmitter	Raw Water Pump PI002 Speed Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0003			
0298	O	TE-I002A	Temperature Element	Raw Water Pump P-I002A Top Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0299	O	TE-I002B	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0300	O	TE-I002C	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0301	O	TE-I002D	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0302	O	TE-I002E	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0303	O	TE-I002F	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0304	O	TE-I002G	Temperature Element	Raw Water Pump P-I002A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0305	O	TE-I002H	Temperature Element	Raw Water Pump P-I002A Bottom Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0003	WB-A0466		
0306		TE-I002I	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0003			
0307		TT-I002I	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0003			
0308		TE-I002J	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0003			
0309		TT-I002J	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0003			
0310	O	VT-I002A	Vibration Indication Transmitter	Raw Water Pump P-I002A Vibration Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0003			
0311	O	PI-I003A	Pressure Indicator	Raw Water Pump P-I003A Outlet Pressure				0-200Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0002		WB-A0404	
0312		PI-I003B	Pressure Indicator	Raw Water Pump P-I003A Outlet Pressure				0-300Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0002		WB-A0404	
0313	O	ST-I003A	Speed Indicator Transmitter	Raw Water Pump P-I003A Speed Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0004			
0314	O	TE-I003A	Temperature Element	Raw Water Pump P-I003A Top Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0315	O	TE-I003B	Temperature Element	Raw Water Pump P-I003A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0316	O	TE-I003C	Temperature Element	Raw Water Pump P-I003A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0317	O	TE-I003D	Temperature Element	Raw Water Pump P-I003A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0318	O	TE-I003E	Temperature Element	Raw Water Pump P-I003A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0319	O	TE-I003F	Temperature Element	Raw Water Pump P-I003A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0320	O	TE-I003G	Temperature Element	Raw Water Pump P-I003A WindingTemperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0321	O	TE-I003H	Temperature Element	Raw Water Pump P-I003A Bottom Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0322		TE-I003I	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0004			
0323		TT-I003I	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0004			
0324		TE-I003J	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0004			
0325		TT-I003J	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0004			
0326	O	VT-I003A	Vibration Indicator Transmitter	Raw Water Pump P-I003A Vibration Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0004			
0327	O	PI-I004A	Pressure Indicator	Raw Water Pump P-I004A Outlet Pressure				0-200Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0002		WB-A0404	
0328		PI-I004B	Pressure Indicator	Raw Water Pump P-I004A Outlet Pressure				0-300Kpa	Pipe	Mech. Contractor	Mech. Contractor		I112	WI-P0002		WB-A0404	
0329	O	ST-I004A	Speed Indicator Transmitter	Raw Water Pump P-I004A Speed Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0004			
0330	O	TE-I004A	Temperature Element	Raw Water Pump P-I004A Top Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0331	O	TE-I004B	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0332	O	TE-I004C	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0333	O	TE-I004D	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0334	O	TE-I004E	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0335	O	TE-I004F	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0336	O	TE-I004G	Temperature Element	Raw Water Pump P-I004A Winding Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0337	O	TE-I004H	Temperature Element	Raw Water Pump P-I004A Bottom Bearing Temperature			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to pump Motor	I131	WI-P0004	WB-A0466		
0338		TE-I004I	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0004			
0339		TT-I004I	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0004			
0340		TE-I004J	Temperature Element	VFD Temperature Monitor			24VDC		Motor	Supply Contractor	Supply Contractor	Fitted to VSD		WI-P0004			
0341		TT-I004J	Temperature Transmitter	VFD Temperature Monitor			120V		Local Control Panel	Supply Contractor	E&I Contractor			WI-P0004			
0342	O	VT-I004A	Vibration Indicator Transmitter	Raw Water Pump P-I004A Vibration Monitor			120V		Motor	Supply Contractor	E&I Contractor			WI-P0004			
0343	O	TT-I011A	Temperature Indicator Transmitter	Train 1 Raw Water Temperature				0-30 C	Head	E&I Contractor	Mech. Contractor		I131	WP-P0001	WB-A0465		WP-M0111
0344	O	TE-I011A	Temperature Element	Train 1 Raw Water Temperature					Thermowell	E&I Contractor	Mech. Contractor		I131	WP-P0001		WB-A0408	WP-M0111
0345	O	TT-I012A	Temperature Indicator Transmitter	Train 2 Raw Water Temperature				0-30 C	Head	E&I Contractor	Mech. Contractor		I131	WP-P0001	WB-A0465		WP-M0111
0346	O	TE-I012A	Temperature Element	Train 2 Raw Water Temperature					Thermowell	E&I Contractor	Mech. Contractor		I131	WP-P0001		WB-A0408	WP-M0111
0347	O	PI-I013A	Pressure Indicator	Train 1 Flash Mixing Pump P-I013A Discharge Pressure Gauge					Pipe	Mech. Contractor	Mech. Contractor		I112	WP-P0001		WB-A0404	WP-M0208
0348	O	PI-I014A	Pressure Indicator	Common Standby Ferric Chloride Dosing Flash Mixing Pump P-I014A Discharge Pressure Gauge					Pipe	Mech. Contractor	Mech. Contractor		I112	WP-P0001		WB-A0404	WP-M0208
0349	O	PI-I015A	Pressure Indicator	Train 2 Flash Mixing Pump P-I015A Discharge Pressure Gauge					Pipe	Mech. Contractor	Mech. Contractor		I112	WP-P0001		WB-A0404	WP-M0208
0350	O	FS-I017D	Flow Switch	Train 1 Ferric Chloride Dosing Flow Low							Mech. Contractor		I105	WP-P0001			
0351	O	FS-I018D	Flow Switch	Train 2 Ferric Chloride Dosing Flow Low							Mech. Contractor		I105	WP-P0001			
0352	O	FS-I022E	Flow Switch	Train 1 Sulphuric Acid Dosing Flow Low							Mech. Contractor		I105	WP-P0001			
0353	O	FS-I023E	Flow Switch	Train 2 Sulfphuric Acid Dosing Flow Low							Mech. Contractor		I105	WP-P0001			
0354	O	AE-I024B	pH Element	Raw Water pH					Backboard	E&I Contractor	E&I Contractor	Analytical instruments shall be mounted on backboards		WP-P0001		WB-A0409	WP-M0111
0355	O	AT-I024B	pH Indicator Transmitter	Raw Water pH					Backboard	E&I Contractor	E&I Contractor			WP-P0001		WB-A0409	WP-M0111
0356	O	FI-I024B	Sample Flow Indicator	Raw Water pH Sample Flow					Backboard	E&I Contractor	E&I Contractor	Rotameter Complete With Low Flow Switch		WP-P0001		WB-A0409	
0357	O	FS-I024B	Flow Switch	Raw Water pH Low Sample Flow					Backboard	E&I Contractor	E&I Contractor		I105	WP-P0001		WB-A0409	WP-M0214
0358	O	AT-I025B	pH Indicator Transmitter	Train 1 Post Flash Mixer Raw Water pH					Backboard	E&I Contractor	E&I Contractor			WP-P0001			WA-E0102
0359	O	AE-I025B	pH Element	Train 1 Post Flash Mixer Raw Water pH					Backboard	E&I Contractor	E&I Contractor			WP-P0001			WA-E0102
0360	O	FI-I025B	Sample Flow Indicator	Train 1 Post Flash Mixer Raw Water pH Sample Flow					Backboard	E&I Contractor	E&I Contractor	Rotameter Complete With Low Flow Switch		WP-P0001			
0361	O	FS-I025B	Flow Switch	Train 1 Post Flash Mixer Raw Water pH Low Sample Flow					Backboard	E&I Contractor	E&I Contractor		I105	-			WA-E0102

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0362	O	AT-I026B	pH Indicator Transmitter	Train 2 Post Flash Mixer Raw Water pH						E&I Contractor	E&I Contractor			WP-P0001			WP-M0111
0363	O	AE-I026B	pH Element	Train 2 Post Flash Mixer Raw Water pH						E&I Contractor	E&I Contractor			WP-P0001			WP-M0111
0364	O	FI-I026B	Sample Flow Indicator	Train 2 Post Flash Mixer Raw Water pH Low Sample Flow						E&I Contractor	E&I Contractor	Rotameter Complete With Low Flow Switch		WP-P0001			
0365	O	FS-I026B	Flow Switch	Train 2 Post Flash Mixer Raw Water pH Sample Flow						E&I Contractor	E&I Contractor		I105	-			WP-M0111
0366	O	AT-I027B	Turbidity Indicator Transmitter	Raw Water Turbidity					Backboard	E&I Contractor	E&I Contractor			WP-P0001		WB-A0409	WP-M0111
0367	O	AE-I027B	Turbidity Element	Raw Water Turbidity					Backboard	E&I Contractor	E&I Contractor			WP-P0001		WB-A0409	WP-M0111
0368	O	FI-I027B	Sample Flow Indicator	Raw Water Turbidity Sample Flow					Backboard	E&I Contractor	E&I Contractor	Rotameter Complete With Low Flow Switch		WP-P0001		WB-A0409	
0369	O	FS-I027B	Flow Switch	Raw Water Turbidity Low Sample Flow					Backboard	E&I Contractor	E&I Contractor		I105	WP-P0001		WB-A0409	WP-M0214
0370	O	AE-J001B	Analyser Element	Softened Water Hardness Monitor										WJ-P0001			
0371	O	AT-J001B	Analyser Indicator Transmitter	Softened Water Hardness Monitor										WJ-P0001			
0372	O	FE-J001A	Flow Element	Softened Water Flow to Salt Saturators and Electrolysers					Flange	Supply Contractor	Mech Contractor	50 mm	I100	WJ-P0001	WB-A0453	WB-A0453	
0373	O	FT-J001A	Flow Indicator Transmitter	Softened Water Flow to Salt Saturators and Electrolysers			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WJ-P0001	WB-A0453	WB-A0402	
0374	O	FI-J002A	Flow Indicator	Softened Water to Sodium Hypochlorite Blending Station Flow										WJ-P0004			
0375	O	TE-J003A	Temperature Element	Softened Water to Electrolyser Temperature									I131	WJ-P0001			
0376	O	TT-J003A	Temperature Transmitter	Softened Water to Electrolysers Temperature									I131	WJ-P0001			
0377	O	LE-J100A	Level Element	Salt Saturator SS-J100A Brine Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0001	WB-A0455	WB-A0401	
0378	O	LT-J100A	Level Indicator Transmitter	Salt Saturator SS-J100A Brine Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0001			
0379	O	LE-J100B	Level Element	Salt Saturator SS-J100A Salt Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0001	WB-A0455	WB-A0401	
0380	O	LT-J100B	Level Indicator Transmitter	Salt Saturator SS-J100A Salt Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0001			
0381	O	LS-J100A	Level Switch	Salt Saturator SS-J100A Brine High Level			120V			Supply Contractor				WJ-P0001			
0382	O	SOL-J100A	Solenoid Actuator	Softened Water Flow Control Valve to Salt Saturator SS-J100A										WJ-P0001			
0383	O	TE-J100A	Temperature Element	Salt Saturator SS-J100A Temperature									I131	WJ-P0001			
0384	O	TT-J100A	Temperature Transmitter	Salt Saturator SS-J100A Temperature									I131	WJ-P0001			
0385	O	LE-J200A	Level Element	Salt Saturator SS-J200A Brine Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0001	WB-A0455	WB-A0401	
0386	O	LT-J200A	Level Indicator Transmitter	Salt Saturator SS-J200A Brine Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0001			
0387	O	LE-J200B	Level Element	Salt Saturator SS-J200A Salt Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0001	WB-A0455	WB-A0401	
0388	O	LT-J200B	Level Indicator Transmitter	Salt Saturator SS-J200A Salt Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0001			
0389	O	LS-J200A	Level Switch	Salt Saturator SS-J200A Brine High Level			120V			Supply Contractor				WJ-P0001			
0390	O	SOL-J200A	Solenoid Actuator	Softened Water Flow Control Valve to Salt Saturator SS-J200A										WJ-P0001			
0391	O	TE-J200A	Temperature Element	Salt Saturator SS-J200A Temperature									I131	WJ-P0001			
0392	O	TT-J200A	Temperature Transmitter	Salt Saturator SS-J200A Temperature									I131	-			
0393	O	PI-J300A	Pressure Indicator	Brine Pump PJ300A Outlet Pressure									I112	WJ-P0002			
0394	O	PI-J310A	Pressure Indicator	Brine Pump PJ310A Outlet Pressure									I112	WJ-P0002			
0395	O	PI-J320A	Pressure Indicator	Brine Pump PJ320A Outlet Pressure									I112	WJ-P0002			
0396	O	PI-J330A	Pressure Indicator	Brine Pump PJ330A Outlet Pressure									I112	WJ-P0002			
0397	O	FI-J400A	Flow Indicator	Softened Water Flow to Electrolyser EL-J400A										WJ-P0003			
0398	O	FS-J400A	Flow Switch	Softened Water Low Flow to Electrolyser EL-J400A										WJ-P0003			
0399	O	FI-J400B	Flow Indicator	Softened Water Flow to Electrolyser EL-J400A										WJ-P0003			
0400	O	FS-J400B	Flow Switch	Softened Water Low Flow to Electrolyser EL-J400A										WJ-P0003			
0401	O	FI-J400C	Flow Indicator	Brine Flow to Electrolyser EL-J400A										WJ-P0003			
0402	O	FS-J400C	Flow Switch	Low Brine Flow to Electrolyser EL-J400A										WJ-P0003			
0403	O	FS-J400D	Flow Switch	Low Brine/ Softened Water Flow to Electrolyser EL-J400A										WJ-P0003			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0404	O	FS-J400E	Flow Switch	Electrolyser EL-J400A Ventilation Low Flow										WJ-P0003			
0405	O	LS-J400A	Level Switch	Electrolyser EL-J400A High Cell Level			120V			Supply Contractor				WJ-P0003			
0406	O	LS-J400B	Level Switch	Electrolyser EL-J400A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0407	O	LS-J400C	Level Switch	Electrolyser EL-J400A High Cell Level			120V			Supply Contractor				WJ-P0003			
0408	O	LS-J400D	Level Switch	Electrolyser EL-J400A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0409	O	PI-J400A	Pressure Indicator	Brine Softened Water Pressure to Electrolyser EL-J400A									I112	WJ-P0003			
0410	O	PS-J400B	Pressure Switch	Electrolyser EL-J400A Cell Pressure High									I115	WJ-P0003			
0411	O	PS-J400C	Pressure Switch	Electrolyser EL-J400A Cell Pressure High									I115	WJ-P0003			
0412	O	PS-J400D	Pressure Switch	Electrolyser EL-J400A Cell Pressure High									I115	WJ-P0003			
0413	O	PS-J400E	Pressure Switch	Electrolyser EL-J400A Cell Pressure High									I115	WJ-P0003			
0414	O	PS-J400D	Pressure Switch	Electrolyser EL-J400A Ventilation High Pressure									I115	WJ-P0003			
0415	O	TS-J400A	Temperature Switch	Electrolyser Rectifier RT-J400 High Temperature										WJ-P0003			
0416	O	FI-J420A	Flow Indicator	Softened Water Flow to Electrolyser EL-J420A										WJ-P0003			
0417	O	FS-J420A	Flow Switch	Softened Water Low Flow to Electrolyser EL-J420A										WJ-P0003			
0418	O	FI-J420B	Flow Indicator	Softened Water Flow to Electrolyser EL-J420A										WJ-P0003			
0419	O	FS-J420B	Flow Switch	Softened Water Low Flow to Electrolyser EL-J420A										WJ-P0003			
0420	O	FI-J420C	Flow Indicator	Brine Flow to Electrolyser EL-J420A										WJ-P0003			
0421	O	FS-J420C	Flow Switch	Low Brine Flow to Electrolyser EL-J420A										WJ-P0003			
0422	O	FS-J420D	Flow Switch	Low Brine/ Softened Water Flow to Electrolyser EL-J420A										WJ-P0003			
0423	O	FS-J420E	Flow Switch	Electrolyser EL-J420A Ventilation Low Flow										WJ-P0003			
0424	O	LS-J420A	Level Switch	Electrolyser EL-J420A High Cell Level			120V			Supply Contractor				WJ-P0003			
0425	O	LS-J420B	Level Switch	Electrolyser EL-J420A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0426	O	LS-J420C	Level Switch	Electrolyser EL-J420A High Cell Level			120V			Supply Contractor				WJ-P0003			
0427	O	LS-J420D	Level Switch	Electrolyser EL-J420A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0428	O	PI-J420A	Pressure Indicator	Brine Softened Water Pressure to Electrolyser EL-J420A									I112	WJ-P0003			
0429	O	PS-J420B	Pressure Switch	Electrolyser EL-J420A Cell Pressure High									I115	WJ-P0003			
0430	O	PS-J420C	Pressure Switch	Electrolyser EL-J420A Cell Pressure High									I115	WJ-P0003			
0431	O	PS-J420D	Pressure Switch	Electrolyser EL-J420A Cell Pressure High									I115	WJ-P0003			
0432	O	PS-J420E	Pressure Switch	Electrolyser EL-J420A Cell Pressure High									I115	WJ-P0003			
0433	O	PS-J420D	Pressure Switch	Electrolyser EL-J420A Ventilation High Pressure									I115	WJ-P0003			
0434	O	TS-J420A	Temperature Switch	Electrolyser Rectifier RT-J420A High Temperature										WJ-P0003			
0435	O	FI-J440A	Flow Indicator	Softened Water Flow to Electrolyser EL-J440A										WJ-P0003			
0436	O	FS-J440A	Flow Switch	Softened Water Low Flow to Electrolyser EL-J440A										WJ-P0003			
0437	O	FI-J440B	Flow Indicator	Softened Water Flow to Electrolyser EL-J440A										WJ-P0003			
0438	O	FS-J440B	Flow Switch	Softened Water Low Flow to Electrolyser EL-J440A										WJ-P0003			
0439	O	FI-J440C	Flow Indicator	Brine Flow to Electrolyser EL-J440A										WJ-P0003			
0440	O	FS-J440C	Flow Switch	Low Brine Flow to Electrolyser EL-J440A										WJ-P0003			
0441	O	FS-J440D	Flow Switch	Low Brine/ Softened Water Flow to Electrolyser EL-J440A										WJ-P0003			
0442	O	FS-J440E	Flow Switch	Electrolyser EL-J440A Ventilation Low Flow										WJ-P0003			
0443	O	LS-J440A	Level Switch	Electrolyser EL-J440A High Cell Level			120V			Supply Contractor				WJ-P0003			
0444	O	LS-J440B	Level Switch	Electrolyser EL-J440A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0445	O	LS-J440C	Level Switch	Electrolyser EL-J440A High Cell Level			120V			Supply Contractor				WJ-P0003			
0446	O	LS-J440D	Level Switch	Electrolyser EL-J440A Low Cell Level			120V			Supply Contractor				WJ-P0003			
0447	O	PI-J440A	Pressure Indicator	Brine Softened Water Pressure to Electrolyser EL-J440A									I112	WJ-P0003			
0448	O	PS-J440B	Pressure Switch	Electrolyser EL-J440A Cell Pressure High									I115	WJ-P0003			
0449	O	PS-J440C	Pressure Switch	Electrolyser EL-J440A Cell Pressure High									I115	WJ-P0003			
0450	O	PS-J440D	Pressure Switch	Electrolyser EL-J440A Cell Pressure High									I115	WJ-P0003			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0451	O	PS-J440E	Pressure Switch	Electrolyser EL-J440A Cell Pressure High									I115	WJ-P0003			
0452	O	PS-J440D	Pressure Switch	Electrolyser EL-J440A Ventilation High Pressure									I115	WJ-P0003			
0453	O	TS-J440A	Temperature Switch	Electrolyser Rectifier RT-J440A High Temperature										WJ-P0003			
0454	O	AE-J450A	Gas Detector	Electrolyser Room Hydrogen Gas Level										WJ-P0003			
0455	O	AT-J450A	Gas Indicator Transmitter	Electrolyser Room Hydrogen Gas Level										WJ-P0003			
0456	O	FI-J480A	Flow Indicator	Sodium Hypochlorite Solution Flow from Truck Delivery to Blending Station										WJ-P0004			
0457	O	FS-J500A	Flow Switch	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Flow Low										WJ-P0005			
0458	O	LE-J500A	Level Element	Sodium Hypochlorite Storage Tank TK-J500A Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0005	WB-A0455	WB-A0401	
0459	O	LT-J500A	Level Indicator Transmitter	Sodium Hypochlorite Storage Tank TK-J500A Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0005			
0460	O	PS-J500A	Pressure Switch	Sodium Hypochlorite Storage Tank TK-J500A Ventilation Pressure High									I115	WJ-P0005			
0461	O	FS-J520A	Flow Switch	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Flow Low										WJ-P0005			
0462	O	LE-J520A	Level Element	Sodium Hypochlorite Storage Tank TK-J520A Level					Flange	E&I Contractor	E&I Contractor		I120	WJ-P0005	WB-A0455	WB-A0401	
0463	O	LT-J520A	Level Indicator Transmitter	Sodium Hypochlorite Storage Tank TK-J520A Level			120V	TBC	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WJ-P0005			
0464	O	PS-J520A	Pressure Switch	Sodium Hypochlorite Storage Tank TK-J520A Ventilation Pressure High									I115	WJ-P0005			
0465	O	AE-J550A	Gas Detector	Sodium Hypochlorite Storage Room Hydrogen Gas Detector										WJ-P0005			
0466	O	AT-J550A	Gas Indicator Transmitter	Sodium Hypochlorite Storage Room Hydrogen Gas Level										WJ-P0005			
0467	O	LS-J550A	Conductivity Level Switch	Sodium Hypochlorite Containmnent Sump High			120V	6mm from floor of containment	Bracket	E&I Contractor	E&I Contractor	To measure any liquid in containment		WJ-P0005	WB-A0458		
0468	O	FE-J600A	Flow Element	Sodium Hypochlorite to Chlorine Contact Tank Influent Flow					Flange	Supply Contractor	Mech Contractor	50 mm	I100	WJ-P0006	WB-A0453	WB-A0453	
0469	O	FT-J600A	Flow Indicator Transmitter	Sodium Hypochlorite to Chlorine Contact Tank Influent Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WJ-P0006	WB-A0453	WB-A0402	
0470	O	LS-J610A	Level Switch	Pump Case Level Switch (Leak Detection)			120V	N/A	Pump Case	Part of pump package				WJ-P0006			
0471	O	PI-J610A	Pressure Indicator	Sodium Hypochlorite Pump PJ610A Outlet Pressure Indicator									I112	WJ-P0006			
0472	O	LS-J620A	Level Switch	Pump Case Level Switch (Leak Detection)			120V	N/A	Pump Case	Part of pump package				WJ-P0006			
0473	O	PI-J620A	Pressure Indicator	Sodium Hypochlorite Pump PJ610A Outlet Pressure Indicator									I112	WJ-P0006			
0474	O	FE-J640A	Flow Element	Sodium Hypochlorite to Filtered Water Channel Flow					Flange	Supply Contractor	Mech Contractor	50 mm	I100	WJ-P0006	WB-A0453	WB-A0453	
0475	O	FT-J640A	Flow Indicator Transmitter	Sodium Hypochlorite to Filtered Water Channel Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WJ-P0006	WB-A0453	WB-A0402	
0476	O	LS-J640A	Level Switch	Pump Case Level Switch (Leak Detection)			120V	N/A	Pump Case	Part of pump package				WJ-P0006			
0477	O	PI-J640A	Pressure Indicator	Sodium Hypochlorite Pump PJ640A Outlet Pressure Indicator									I112	WJ-P0006			
0478	O	LS-J660A	Level Switch	Pump Case Level Switch (Leak Detection)			120V	N/A	Pump Case	Part of pump package				WJ-P0006			
0479	O	PI-J660A	Pressure Indicator	Sodium Hypochlorite Pump PJ660A Outlet Pressure Indicator									I112	WJ-P0006			
0480		FE-J701A	Flow Element	Re- circ pump P-J701A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	100mm	I100	WF-P0011	WB-A0453	WB-A0453	WC-M0209
0481		FT-J701A	Flow Indicator Transmitter	Re- circ pump P-J701A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0011	WB-A0453	WB-A0402	WC-M0209
0482		FE-J702A	Flow Element	Re- circ pump P-J702A Outlet Flow					Flange	Mech. Contractor	Mech. Contractor	100mm	I100	WF-P0011	WB-A0453	WB-A0453	WC-M0209
0483		FT-J702A	Flow Indicator Transmitter	Re- circ pump P-J702A Outlet Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WF-P0011	WB-A0453	WB-A0402	WC-M0209
0484	O	LE-L920A	Level Element	Freeze Thaw Ponds Dewatering Pump Station Level						E&I Contractor	E&I Contractor		I120	WL-P0002	WB-A0455	WB-A0401	
0485	O	LT-L920A	Level Indicator Transmitter	Dewatering Pump Station TKR920A Level			120V	0-2 mtrs	Wall/ Stand			Included in Freeze/ Thaw ponds contract	I120	WL-P0002			
0486	O	LS-L920A	Level Switch	Dewatering Pump Station TKR920A High High Level			120V		Flange	E&I Contractor	E&I Contractor	Included in Freeze/ Thaw ponds contract	I125	WL-P0002	WB-A0463	WB-A0406	
0487	O	LS-L920B	Level Switch	Dewatering Pump Station TKR920A Low Low Level			120V		Flange	E&I Contractor	E&I Contractor	Included in Freeze/ Thaw ponds contract	I125	WL-P0002	WB-A0463	WB-A0406	
0488	O	AE-L924A	Analyser Element	Combined Dewatering Pump Outlet TSS								Included in Freeze/ Thaw ponds contract		WL-P0002			
0489	O	FE-L924A	Flow Element	Combined Dewatering Pump Outlet Flow					Flange			150 mm Included in Freeze/ Thaw ponds contract	I100	WL-P0002	WB-A0453	WB-A0453	

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0490	O	FT-L924A	Flow Indicator Transmitter	Combined Dewatering Pump Outlet Flow			120V		Wall/Stand			Included in Freeze/ Thaw ponds contract	I100	WL-P0002	WB-A0453	WB-A0402	
0491	O	PI-L924A	Pressure Indicator	Combined Dewatering Pump Outlet Pressure								Included in Freeze/ Thaw ponds contract	I112	WL-P0002			
0492	O	LE-O010A	Level Element	Liquid Oxygen Storage Tank #1 Level						Supply Contractor	Supply Contractor			WO-P0001			TBC
0493	O	LT-O010A	Level Indicator Transmitter	Liquid Oxygen Storage Tank #1 Level				TBC	Wall/ Stand	Supply Contractor	Supply Contractor			WO-P0001			TBC
0494	O	LS-O010A	Level Switch	Liquid Oxygen Storage Tank #1 Level Low			120V		TBC	Supply Contractor	Supply Contractor			WO-P0001			
0495	O	PT-O010A	Pressure Indicator Transmitter	Liquid Oxygen Storage Tank #1 Pressure			Loop Powered	TBC		Supply Contractor	Mech. Contractor		I111	WO-P0001			
0496	O	PS-O010A	Pressure Switch	Liquid Oxygen Storage Tank #1 Pressure High									I115	WO-P0001			
0497	O	PI-O012A	Pressure Indicator	Liquid Oxygen Storage Tank Outlet Presuure									I112	WO-P0001			
0498	O	TE-O012A	Temperature Element	Liquid Oxygen Tank Oxygen Temperature									I131	WO-P0001			
0499	O	TT-O012A	Temperature Indicator Transmitter	Liquid Oxygen Tank Oxygen Temperature									I131	WO-P0001			
0500	O	PT-O015A	Pressure Indicator Transmitter	Liquid Oxygen Storage Tank Outlet Pressure			Loop Powered	TBC		Supply Contractor	Mech. Contractor		I111	WO-P0001			
0501	O	LE-O020A	Level Element	Liquid Oxygen Storage Tank #2 Level						Supply Contractor	Supply Contractor			WO-P0002			TBC
0502	O	LT-O020A	Level Indicator Transmitter	Liquid Oxygen Storage Tank #2 Level				TBC	Wall/ Stand	Supply Contractor	Supply Contractor			WO-P0002			TBC
0503	O	LS-O020A	Level Switch	Liquid Oxygen Storage Tank #2 Level Low			120V		TBC	Supply Contractor	Supply Contractor			WO-P0002			
0504	O	PT-O020A	Pressure Indicator Transmitter	Liquid Oxygen Storage Tank #2 Pressure			Loop Powered	TBC		Supply Contractor	Mech. Contractor		I111	WO-P0002			
0505	O	PS-O020A	Pressure Switch	Liquid Oxygen Storage Tank #2 Pressure High									I115	WO-P0002			
0506	O	PT-O030A	Pressure Indicator Transmitter	Liquid Oxygen Particle Filter GFO030 Differential Pressure			Loop Powered	13 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0003	WB-A0465	WB-A0404	
0507	O	AE-O032A	Analyser Element	Liquid Oxygen to Ozone Generators Dewpoint Analyzer										WO-P0003			WO-M0402
0508	O	AT-O032A	Dew Point Analyzer	Liquid Oxygen to Ozone Generators Dewpoint Analyzer										WO-P0003			WO-M0402
0509	O	PI-O032A	Pressure Indicator	Liquid Oxygen to Ozone Generators Pressure Indicator									I112	WO-P0003			
0510	O	PI-O050A	Pressure Indicator	Nitrogen Boost Air Receiver Pressure									I112	WO-P0004			
0511	O	PS-O050A	Pressure Switch	Nitrogen Boost Air Receiver Pressure Switch High									I115	WO-P0004			
0512	O	AE-O051A	Analyser Element	Nitrogen Boost Unit to Ozone Generator Dewpoint										WO-P0004			WO-M0401
0513	O	AT-O051A	Dew Point Analyzer	Nitrogen Boost Unit to Ozone Generator Dewpoint										WO-P0004			WO-M0401
0514	O	FI-O051A	Flow Indicator	Nitrogen Boost Unit to Ozone Generators Flow										WO-P0004			WO-M0401
0515	O	FS-O051A	Flow Switch	Nitrogen Boost Unit to Ozone Generators Low Flow										WO-P0004			WO-M0401
0516	O	PI-O051A	Pressure Indicator	Nitrogen Boost Unit to Ozone Generators Pressure									I112	WO-P0004			WO-M0401
0517	O	AE-O110A	Gas Sensor	Ambient Ozone Gas										WO-P0005			WO-M0204
0518	O	AT-O110A	Gas Level Indicator Transmitter	Ambient Ozone Gas Level										WO-P0005			WO-M0204
0519	O	AE-O110B	Gas Sensor	Ambient Oxygen Gas										WO-P0005			WO-M0206
0520	O	AT-O110B	Gas Level Indicator Transmitter	Ambient Oxygen Gas Level										WO-P0005			WO-M0206
0521	O	PT-O110A	Pressure Indicator Transmitter	Liquid Oxygen to Ozone Generator GEN-O110A Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0005	WB-A0465	WB-A0404	WO-M0204
0522	O	TE-O110A	Temperature Element	Liquid Oxygen to Ozone Generator GEN-O110A Temperature									I131	WO-P0005			WO-M0204
0523	O	TT-O110A	Temperature Indicator Transmitter	Liquid Oxygen to Ozone Generator GEN-O110A Temperature									I131	WO-P0005			WO-M0204
0524	O	PT-O111A	Pressure Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Pressure			Loop Powered	0-400 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0016	WB-A0465		
0525	O	AE-O112A	Analyser Element	Ozone Generator GEN-O110A Outlet Ozone Gas										WO-P0005			WO-M0204
0526	O	AT-O112A	Analyser Indicator Transmitter	Ozone Generator GEN-O110A Outlet Ozone Gas										WO-P0005			WO-M0204
0527	O	FE-O112A	Flow Element	Ozone Generator GEN-O110A Flow					Spool piece	Supply Contractor	Mech. Contractor	50 mm	I101	WO-P0005			
0528	O	FT-O112A	Flow Indicator Transmitter	Ozone Generator GEN-O110A Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0005	WB-A0454		
0529	O	PT-O112A	Pressure Indicator Transmitter	Ozone Generator GEN-O110A Outlet Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0005	WB-A0465	WB-A0404	WO-M0204
0530	O	TE-O112A	Temperature Element	Ozone Generator GEN-O110A Outlet Temperature									I131	WO-P0005			
0531	O	TT-O112A	Temperature Indicator Transmitter	Ozone Generator GEN-O110A Outlet Temperature									I131	WO-P0005			
0532	O	AE-O130A	Gas Sensor	Ambient Ozone Gas										WO-P0006			WO-M0204
0533	O	AT-O130A	Gas Level Indicator Transmitter	Ambient Ozone Gas Level										WO-P0006			WO-M0204
0534	O	AE-O130B	Gas Sensor	Ambient Oxygen Gas										WO-P0006			WO-M0205
0535	O	AT-O130B	Gas Level Indicator Transmitter	Ambient Oxygen Gas Level										WO-P0006			WO-M0205

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0536	O	PT-O130A	Pressure Indicator Transmitter	Liquid Oxygen to Ozone Generator GEN-O130A Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0006	WB-A0465	WB-A0404	WO-M0204
0537	O	TE-O130A	Temperature Element	Liquid Oxygen to Ozone Generator GEN-O130A Temperature									I131	WO-P0006			WO-M0204
0538	O	TT-O130A	Temperature Transmitter	Liquid Oxygen to Ozone Generator GEN-O130A Temperature									I131	WO-P0006			WO-M0204
0539	O	PT-O131A	Pressure Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420A Inlet Pressure			Loop Powered	0-400 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0017	WB-A0465		
0540	O	AE-O132A	Analyser Element	Ozone Generator GEN-O130A Outlet Ozone Gas										WO-P0006			WO-M0204
0541	O	AT-O132A	Analyser Indicator Transmitter	Ozone Generator GEN-O130A Outlet Ozone Gas										WO-P0006			WO-M0204
0542	O	FE-O132A	Flow Element	Ozone Generator GEN-O130A Flow					Spool piece	Supply Contractor	Mech. Contractor	50 mm	I101	WO-P0006			
0543	O	FT-O132A	Flow Indicator Transmitter	Ozone Generator GEN-O130A Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0006	WB-A0454		
0544	O	PT-O132A	Pressure Indicator Transmitter	Ozone Generator GEN-O130A Outlet Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0006	WB-A0465	WB-A0404	WO-M0204
0545	O	TE-O132A	Temperature Element	Ozone Generator GEN-O130A Outlet Temperature									I131	WO-P0006			WO-M0403
0546	O	TT-O132A	Temperature Indicator Transmitter	Ozone Generator GEN-O130A Outlet Temperature									I131	WO-P0006			WO-M0403
0547	O	AE-O150A	Gas Sensor	Ambient Ozone Gas										WO-P0007			WO-M0202
0548	O	AT-O150A	Gas Level Indicator Transmitter	Ambient Ozone Gas Level										WO-P0007			WO-M0202
0549	O	PT-O150A	Pressure Indicator Transmitter	Liquid Oxygen to Ozone Generator GEN-O150A Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0007	WB-A0465	WB-A0404	WO-M0204
0550	O	TE-O150A	Temperature Element	Liquid Oxygen to Ozone Generator GEN-O150A Temperature									I131	WO-P0007			WO-M0204
0551	O	TT-O150A	Temperature Transmitter	Liquid Oxygen to Ozone Generator GEN-O150A Temperature									I131	WO-P0007			WO-M0204
0552	O	TE-O150A	Temperature Element	Ozone Generator GEN-O150A Outlet Temperature									I131	WO-P0007			
0553	O	TT-O150A	Temperature Indicator Transmitter	Ozone Generator GEN-O150A Outlet Temperature									I131	WO-P0007			
0554	O	PT-O151A	Pressure Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Inlet Pressure			Loop Powered	0-400 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0018	WB-A0465		
0555	O	AE-O152A	Analyser Element	Ozone Generator GEN-O150A Outlet Ozone Gas										WO-P0007			WO-M0204
0556	O	AT-O152A	Analyser Indicator Transmitter	Ozone Generator GEN-O150A Outlet Ozone Gas										WO-P0007			WO-M0204
0557	O	FE-O152A	Flow Element	Ozone Generator GEN-O150A Flow					Spool piece	Supply Contractor	Mech. Contractor	50 mm	I101	WO-P0007			
0558	O	FT-O152A	Flow Indicator Transmitter	Ozone Generator GEN-O150A Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0007	WB-A0454		
0559	O	PT-O152A	Pressure Indicator Transmitter	Ozone Generator GEN-O150A Outlet Pressure			Loop Powered	0-206 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0007	WB-A0465	WB-A0404	WO-M0204
0560	O	FE-O216A	Flow Element	Ozone Injection Line to Ozone Contactor #1 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0008			
0561	O	FT-O216A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #1 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0008	WB-A0454		
0562	O	FE-O217A	Flow Element	Ozone Injection Line to Ozone Contactor #1 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0008			
0563	O	FT-O217A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #1 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0008	WB-A0454		
0564	O	FE-O218A	Flow Element	Ozone Injection Line to Ozone Contactor #1 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0008			
0565	O	FT-O218A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #1 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0008	WB-A0454		
0566	O	FS-O220A	Flow Indicator Transmitter	Sample Element SE-0210A Dissolved Ozone Sample Flow						Supply Contractor	Mech. Contractor			WO-P0022			
0567	O	SP-O220A	Sample Pump	Sample Element SE-0210A Dissolved Ozone Sample										WO-P0022			WO-M0203
0568	O	AE-O221A	Analyser Element	Sample Element SE-0210A Dissolved Ozone Sample Analyser										WO-P0022			
0569	O	AT-O221A	Analyser Indicator Transmitter	Sample Element SE-0210A Dissolved Ozone Sample Analyser										WO-P0022			
0570	O	FI-O222A	Flow Indicator	Sample Element SE-0210A Dissolved Ozone Sample Flow										WO-P0022			
0571	O	FS-O222A	Flow Switch	Sample Element SE-0210A Dissolved Ozone Sample Low Flow										WO-P0022			
0572	O	FS-O225A	Flow Indicator Transmitter	Sample Element SE-0210B Dissolved Ozone Sample Flow						Supply Contractor	Mech. Contractor			WO-P0022			
0573	O	SP-O225A	Sample Pump	Sample Element SE-0210B Dissolved Ozone Sample										WO-P0022			WO-M0205
0574	O	AE-O226A	Analyser Element	Sample Element SE-0210B Dissolved Ozone Sample Analyser										WO-P0022			
0575	O	AT-O226A	Analyser Indicator Transmitter	Sample Element SE-0210B Dissolved Ozone Sample Analyser										WO-P0022			
0576	O	FI-O227A	Flow Indicator	Sample Element SE-0210B Dissolved Ozone Sample Flow										WO-P0022			
0577	O	FS-O227A	Flow Switch	Sample Element SE-0210B Dissolved Ozone Sample Low Flow										WO-P0022			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0578	O	FE-O236A	Flow Element	Ozone Injection Line to Ozone Contactor #2 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0009			
0579	O	FT-O236A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #2 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0009	WB-A0454		
0580	O	FE-O237A	Flow Element	Ozone Injection Line to Ozone Contactor #2 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0009			
0581	O	FT-O237A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #2 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0009	WB-A0454		
0582	O	FE-O238A	Flow Element	Ozone Injection Line to Ozone Contactor #2 Flow					Spool piece	Supply Contractor	Mech. Contractor	38 mm	I101	WO-P0009			
0583	O	FT-O238A	Flow Indicator Transmitter	Ozone Injection Line to Ozone Contactor #2 Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I101	WO-P0009	WB-A0454		
0584	O	FS-O240A	Flow Indicator Transmitter	Sample Element SE-0230A Dissolved Ozone Sample Flow						Supply Contractor	Mech. Contractor			WO-P0023			
0585	O	SP-O240A	Sample Pump	Sample Element SE-0230A Dissolved Ozone Sample										WO-P0023			WO-M0201
0586	O	AE-O241A	Analyser Element	Sample Element SE-0230A Dissolved Ozone Sample Analyser										WO-P0023			
0587	O	AT-O241A	Analyser Indicator Transmitter	Sample Element SE-0230A Dissolved Ozone Sample Analyser										WO-P0023			
0588	O	FI-O242A	Flow Indicator	Sample Element SE-0230A Dissolved Ozone Sample Flow										WO-P0023			
0589	O	FS-O242A	Flow Switch	Sample Element SE-0230A Dissolved Ozone Sample Low Flow										WO-P0023			
0590	O	FS-O245A	Flow Indicator Transmitter	Sample Element SE-0230B Dissolved Ozone Sample Flow						Supply Contractor	Mech. Contractor			WO-P0023			
0591	O	SP-O245A	Sample Pump	Sample Element SE-0230B Dissolved Ozone Sample										WO-P0023			WO-M0201
0592	O	AE-O246A	Analyser Element	Sample Element SE-0230B Dissolved Ozone Sample Analyser										WO-P0023			
0593	O	AT-O246A	Analyser Indicator Transmitter	Sample Element SE-0230B Dissolved Ozone Sample Analyser										WO-P0023			
0594	O	FI-O247A	Flow Indicator	Sample Element SE-0230B Dissolved Ozone Sample Flow										WO-P0023			
0595	O	FS-O277A	Flow Switch	Sample Element SE-0230B Dissolved Ozone Sample Low Flow										WO-P0023			
0596	O	FI-O310A	Flow Indicator	Open Loop Cooling Water to Power Supply Unit PSU-O310A Flow										WO-P0019			WO-M0205
0597	O	TS-O310A	Temperature Switch	Electrolyser Power Supply Unit PSU-O310A High Temperature										WO-P0019			
0598	O	FI-O320A	Flow Indicator	Open Loop Cooling Water to Power Supply Unit PSU-O320A Flow										WO-P0020			WO-M0205
0599	O	TS-O320A	Temperature Switch	Electrolyser Power Supply Unit PSU-O320A High Temperature										WO-P0020			
0600	O	FI-O330A	Flow Indicator	Open Loop Cooling Water to Power Supply Unit PSU-O330A Flow										WO-P0021			WO-M0205
0601	O	TS-O330A	Temperature Switch	Electrolyser Power Supply Unit PSU-O330A High Temperature										WO-P0021			
0602	O	AE-O404A	Analyser Element	Open Loop Cooling Water Turbidity										WO-P0015			WO-M0206
0603	O	AT-O404A	Analyzer Indicator Transmitter	Open Loop Cooling Water Turbidity										WO-P0015			WO-M0206
0604	O	FI-O404A	Variable Area Flowmeter	Open Loop Cooling Water to Turbidity Analyzer Flow										WO-P0015			
0605	O	FS-O404A	Flow Switch	Open Loop Cooling Water to Turbidity Analyzer Low Flow										WO-P0015			
0606	O	FE-O410A	Flow Element	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm	I100	WO-P0016	WB-A0453	WB-A0453	
0607	O	FT-O410A	Flow Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WO-P0016	WB-A0465		
0608	O	PI-O410A	Pressure Indicator	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Pressure									I112	WO-P0016			
0609	O	PI-O410B	Pressure Indicator	Open Loop Cooling Water to Heat Exchanger HEX-O410A Outlet Pressure									I112	WO-P0016			
0610	O	TE-O410A	Temperature Element	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Temperature									I131	WO-P0016			
0611	O	TT-O410A	Temperature Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O410A Inlet Temperature									I131	WO-P0016			
0612	O	TE-O410B	Temperature Element	Open Loop Cooling Water to Heat Exchanger HEX-O410A Outlet Temperature									I131	WO-P0016			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0613	O	TT-O410B	Temperature Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O410A Outlet Temperature									I131	WO-P0016			
0614	O	CE-O411A	Conductivity Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Outlet Conductivity										WO-P0016			
0615	O	CT-O411A	Conductivity Indicator Transmitter	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Outlet Conductivity										WO-P0016			
0616	O	FE-O411A	Flow Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410 Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm Rotary Flowmeter		WO-P0016			
0617	O	FT-O411A	Flow Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor			WO-P0016			
0618	O	PI-O411A	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Pump Outlet Pressure									I112	WO-P0016			
0619	O	PI-O411B	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0410A Outlet Pressure									I112	WO-P0016			
0620	O	SOL-O411A	Solenoid Actuator	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0410A										WO-P0016			
0621	O	TE-O411A	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Temperature									I131	WO-P0016			
0622	O	TT-O411A	Temperature Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Inlet Temperature									I131	WO-P0016			
0623	O	TE-O411B	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Outlet Temperature									I131	WO-P0016			
0624	O	TT-O411B	Temperature Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0410 Outlet Temperature									I131	WO-P0016			
0625	O	FE-O420A	Flow Element	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm	I100	WO-P0017	WB-A0453	WB-A0453	
0626	O	FT-O420A	Flow Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WO-P0017	WB-A0465		
0627	O	PI-O420A	Pressure Indicator	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Pressure									I112	WO-P0017			
0628	O	PI-O420B	Pressure Indicator	Open Loop Cooling Water to Heat Exchanger HEX-O420A Outlet Pressure									I112	WO-P0017			
0629	O	TE-O420A	Temperature Element	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Temperature									I131	WO-P0017			
0630	O	TT-O420A	Temperature Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O420A Inlet Temperature									I131	WO-P0017			
0631	O	TE-O420B	Temperature Element	Open Loop Cooling Water to Heat Exchanger HEX-O420A Outlet Temperature									I131	WO-P0017			
0632	O	TT-O420B	Temperature Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O420A Outlet Temperature									I131	WO-P0017			
0633	O	CE-O421A	Conductivity Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Outlet Conductivity										WO-P0017			
0634	O	CT-O421A	Conductivity Indicator Transmitter	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Outlet Conductivity										WO-P0017			
0635	O	FE-O421A	Flow Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm Rotary Flowmeter		WO-P0017			
0636	O	FT-O421A	Flow Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420A Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor			WO-P0017			
0637	O	PI-O421A	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Pump Outlet Pressure									I112	WO-P0017			
0638	O	PI-O421B	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0420A Outlet Pressure									I112	WO-P0017			
0639	O	SOL-O421A	Solenoid Actuator	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0420A										WO-P0017			
0640	O	TE-O421A	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420A Inlet Temperature									I131	WO-P0017			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0641	O	TT-O421A	Temperature Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420A Inlet Temperature									I131	WO-P0017			
0642	O	TE-O421B	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0420A Outlet Temperature									I131	WO-P0017			
0643	O	TT-O421B	Temperature Indicator Transmitter	0420A Outlet Temperature									I131	WO-P0017			
0644	O	FE-O430A	Flow Element	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm	I100	WO-P0018	WB-A0453	WB-A0453	
0645	O	FT-O430A	Flow Indicator Transmitter	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor		I100	WO-P0018	WB-A0465		
0646	O	PI-O430A	Pressure Indicator	Open Loop Cooling Water to Heat Exchanger HEX-O430A Inlet Pressure									I112	WO-P0018			
0647	O	PI-O430B	Pressure Indicator	Pressure									I112	WO-P0018			
0648	O	TE-O430A	Temperature Element	Temperature									I131	WO-P0018			
0649	O	TT-O430A	Temperature Indicator Transmitter	Temperature									I131	WO-P0018			
0650	O	TE-O430B	Temperature Element	Temperature									I131	WO-P0018			
0651	O	TT-O430B	Temperature Indicator Transmitter	Temperature									I131	WO-P0018			
0652	O	CE-O431A	Conductivity Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Outlet Conductivity										WO-P0018			
0653	O	CT-O431A	Conductivity Indicator Transmitter	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Outlet Conductivity										WO-P0018			
0654	O	FE-O431A	Flow Element	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Inlet Flow					Flange	Supply Contractor	Mech. Contractor	75 mm Rotary Flowmeter		WO-P0018			
0655	O	FT-O431A	Flow Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Inlet Flow			120V		Wall/Stand	Supply Contractor	E&I Contractor			WO-P0018			
0656	O	PI-O431A	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Pump Outlet Pressure									I112	WO-P0018			
0657	O	PI-O431B	Pressure Indicator	Ozone Generator Closed Loop Cooling Water to Heat Exchanger HEX-0430A Outlet Pressure									I112	WO-P0018			
0658	O	SOL-O431A	Solenoid Actuator	Ozone Generator Closed Loop Cooling Water De-Ionized Water to Heat Exchanger HEX-0430A										WO-P0018			
0659	O	TE-O431A	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Inlet Temperature									I131	WO-P0018			
0660	O	TT-O431A	Temperature Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Inlet Temperature									I131	WO-P0018			
0661	O	TE-O431B	Temperature Element	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Outlet Temperature									I131	WO-P0018			
0662	O	TT-O431B	Temperature Indicator Transmitter	Ozone Generator Closed Looop Cooling Water to Heat Exchanger HEX-0430A Outlet Temperature									I131	WO-P0018			
0663	O	PT-O501A	Pressure Indicator Transmitter	Ozone Contactor #1 to Ozone Destruct Units Pressure			Loop Powered	-7.5 Kpa to 7.5 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0012	WB-A0465		WO-M0202
0664	O	PT-O501B	Pressure Indicator Transmitter	Ozone Contactor #1 to Ozone Destruct Units Demister Differential Pressure			Loop Powered	0-1.25 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0012	WB-A0465		WO-M0202
0665	O	AE-O505A	Gas Sensor	Ozone Contactor #2 to Ozone Destruct Analyzer										WO-P0014			WO-M0202
0666	O	AT-O505A	Gas Analyzer Indicator Transmitter	Ozone Contactor #2 to Ozone Destruct Analyzer										WO-P0014			WO-M0202
0667	O	PT-O505A	Pressure Indicator Transmitter	Ozone Contactor #2 to Ozone Destruct Units Pressure			Loop Powered	-7.5 Kpa to 7.5 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0014	WB-A0465		WO-M0202
0668	O	PT-O505B	Pressure Indicator Transmitter	Ozone Contactor #2 to Ozone Destruct Units Demister Differential Pressure			Loop Powered	0-10 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0014	WB-A0465		WO-M0202
0669	O	AE-O510A	Gas Sensor	Ozone Contactor #1 to Ozone Destruct Analyzer										WO-P0012			
0670	O	AT-O510A	Gas Analyzer Indicator Transmitter	Ozone Contactor #1 to Ozone Destruct Analyzer										WO-P0012			
0671	O	AE-O510B	Analyser Element	Ozone Destruct Unit #1 Vent Ozone Analyzer										WO-P0012			
0672	O	AT-O510B	Ozone Gas Analyzer Indicator Transmitter	Ozone Destruct Unit #1 Vent Ozone Analyzer										WO-P0012			
0673	O	PT-O510A	Pressure Indicator Transmitter	Catalytic Destruct Unit CDU-O510 Differential Pressure			Loop Powered	0-5 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0012	WB-A0465		
0674	O	PT-O510B	Pressure Indicator Transmitter	Ozone Destruct Unit #1 Blower Differential Pressure			Loop Powered	0-10 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0012	WB-A0465		
0675	O	TE-O510A	Temperature Element	Ozone Destruct Unit #1 Heater Inlet Temperature									I131	WO-P0012			
0676	O	TT-O510A	Temperature Indicator Transmitter	Ozone Destruct Unit #1 Heater Inlet Temperature									I131	WO-P0012			
0677	O	TE-O510B	Temperature Element	Ozone Destruct Unit #1 Heater Outlet Temperature									I131	WO-P0012			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0678	O	TT-O510B	Temperature Indicator Transmitter	Ozone Destruct Unit #1 Heater Outlet Temperature									I131	WO-P0012			
0679	O	TE-O510C	Temperature Element	Catalytic Destruct Unit CDU-O510A Outlet Temperature									I131	WO-P0012			
0680	O	TT-O510C	Temperature Indicator Transmitter	Catalytic Destruct Unit CDU-O510A Outlet Temperature									I131	WO-P0012			
0681	O	AE-O520A	Analyser Element	Ozone Destruct Unit #2 Vent Ozone Analyzer										WO-P0013			
0682	O	AT-O520A	Ozone Gas Analyzer Indicator Transmitter	Ozone Destruct Unit #2 Vent Ozone Analyzer										WO-P0013			
0683	O	AE-O520B	Analyser Element	Ambient Ozone Gas Sensor										WO-P0013			
0684	O	AT-O520B	Ozone Gas Analyzer Indicator Transmitter	Ambient Ozone Gas Level										WO-P0013			
0685	O	PT-O520A	Pressure Indicator Transmitter	Catalytic Destruct Unit CDU-O520A Differential Pressure			Loop Powered	0-5 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0013	WB-A0465		
0686	O	PT-O520B	Pressure Indicator Transmitter	Ozone Destruct Unit #2 Blower Differential Pressure			Loop Powered	0-10 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0013	WB-A0465		
0687	O	TE-O520A	Temperature Element	Ozone Destruct Unit #2 Heater Inlet Temperature									I131	WO-P0013			
0688	O	TT-O520A	Temperature Indicator Transmitter	Ozone Destruct Unit #2 Heater Inlet Temperature									I131	WO-P0013			
0689	O	TE-O520B	Temperature Element	Ozone Destruct Unit #2 Heater Outlet Temperature									I131	WO-P0013			
0690	O	TT-O520B	Temperature Indicator Transmitter	Ozone Destruct Unit #2 Heater Outlet Temperature									I131	WO-P0013			
0691	O	TE-O520C	Temperature Element	Catalytic Destruct Unit CDU-O520A Outlet Temperature									I131	WO-P0013			
0692	O	TT-O520C	Temperature Indicator Transmitter	Catalytic Destruct Unit CDU-O520A Outlet Temperature									I131	WO-P0013			
0693	O	AE-O530A	Analyser Element	Ozone Destruct Unit #3 Vent Ozone Analyzer										WO-P0014			
0694	O	AT-O530A	Ozone Gas Analyzer Indicator Transmitter	Ozone Destruct Unit #3 Vent Ozone Analyzer										WO-P0014			
0695	O	PT-O530A	Pressure Indicator Transmitter	Catalytic Destruct Unit CDU-O530 Differential Pressure			Loop Powered	0-5 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0014	WB-A0465		
0696	O	PT-O530B	Pressure Indicator Transmitter	Ozone Destruct Unit #3 Blower Differential Pressure			Loop Powered	0-10 Kpa	Manifold	Supply Contractor	Mech. Contractor		I111	WO-P0014	WB-A0465		
0697	O	TE-O530A	Temperature Element	Ozone Destruct Unit #3 Heater Inlet Temperature									I131	WO-P0014			
0698	O	TT-O530A	Temperature Indicator Transmitter	Ozone Destruct Unit #3 Heater Inlet Temperature									I131	WO-P0014			
0699	O	TE-O530B	Temperature Element	Ozone Destruct Unit #3 Heater Outlet Temperature									I131	WO-P0014			
0700	O	TT-O530B	Temperature Indicator Transmitter	Ozone Destruct Unit #3 Heater Outlet Temperature									I131	WO-P0014			
0701	O	TE-O530C	Temperature Element	Catalytic Destruct Unit CDU-O530A Outlet Temperature									I131	WO-P0014			
0702	O	TT-O530C	Temperature Indicator Transmitter	Catalytic Destruct Unit CDU-O530A Outlet Temperature									I131	WO-P0014			
0703	O	PT-OO31A	Pressure Indicator Transmitter	Liquid Oxygen Particle Filter GFO031 Differential Pressure			Loop Powered	13 Kpa	Gauge Valve	Supply Contractor	Mech. Contractor		I111	WO-P0003	WB-A0465	WB-A0404	
0704	O	FT-P001A	Flow Indicator Transmitter	DAF Recycle Water Flow to Saturator P001A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0013	WB-A0453	WB-A0402	WP-M0213
0705	O	FE-P001A	Flow Element	DAF Recycle Water Flow to Saturator P001A				0-150 L/s	Flange	Mech. Contractor	Mech. Contractor	250 mm	I100	WP-P0013	WB-A0453	WB-A0453	WP-M0213
0706	O	LT-P001A	Level Indicator Transmitter	DAF Saturator Vessel P001A Level			Loop powered	0-600 mm	Transmitter mounted on bypass level indicator	Supply Contractor	Supply Contractor			WP-P0013	WB-A0465		WP-M0213
0707	O	LE-P001A	Level Element	DAF Saturator Vessel P001A Level					By pass indicator	Supply Contractor	Mech. Contractor			WP-P0013	WB-A0465		WP-M0213
0708	O	LS-P001A	Level Switch	DAF Saturator Vessel P001A Level Low			120V	50.8mm	Flange	Supply Contractor	Mech. Contractor		N/A	WP-P0013	WB-A0463	N/A	WP-M0213
0709	O	PT-P001A	Pressure Indicator Transmitter	DAF Saturator Vessel P001A Pressure			Loop Powered	0-1000 Kpa	Flange	Supply Contractor	Mech. Contractor		I111	WP-P0013	WB-A0465	WB-A0408	WP-M0131
0710	O	PI-P001A	Pressure Indicator	DAF Saturator Vessel P001A Pressure Reducing Valve						Supply Contractor	Mech. Contractor		I112	WP-P0013			WP-M0131
0711	O	PI-P001B	Pressure Indicator	DAF Saturator Vessel P001A Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0013			
0712	O	PS-P001A	Pressure Switch	DAF Saturator Vessel P001A Pressure Low						Supply Contractor	Mech. Contractor		I115	WP-P0013			WP-M0213
0713	O	SOL-P001A	Solenoid Actuator	DAF Saturator Vessel P001A Outlet Flow Shutoff Valve Actuator						Supply Contractor	Mech. Contractor			WP-P0013			
0714	O	TT-P001A	Temperature Indicator Transmitter	DAF Saturator Vessel P001A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0013			WP-M0213
0715	O	TE-P001A	Temperature Element	DAF Saturator Vessel P001A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0013			WP-M0213
0716	O	FT-P002A	Flow Indicator Transmitter	DAF Recycle Water Flow to Saturator P002A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0013	WB-A0453	WB-A0402	WP-M0206
0717	O	FE-P002A	Flow Element	DAF Recycle Water Flow to Saturator P002A				0-150 L/s	Flange	Mech. Contractor	Mech. Contractor	250 mm	I100	WP-P0013	WB-A0453	WB-A0453	WP-M0206

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0718	O	LT-P002A	Level Indicator Transmitter	DAF Saturator Vessel P002A Level			Loop powered	0-600 mm	Transmitter mounted on bypass level indicator	Supply Contractor	Supply Contractor			WP-P0013	WB-A0465		WP-E0133
0719	O	LE-P002A	Level Element	DAF Saturator Vessel P002A Level					By pass indicator	Supply Contractor	Mech. Contractor			WP-P0013	WB-A0465		WP-E0133
0720	O	LS-P002A	Level Switch	DAF Saturator Vessel P002A Level Low			120V	50.8mm	Flange	Supply Contractor	Mech. Contractor		N/A	WP-P0013	WB-A0463	N/A	WP-E0133
0721	O	PT-P002A	Pressure Indicator Transmitter	DAF Saturator Vessel P002A Pressure			Loop Powered	0-1000 Kpa	Flange	Supply Contractor	Mech. Contractor		I111	WP-P0013	WB-A0465	WB-A0408	
0722	O	PI-P002A	Pressure Indicator	DAF Saturator Vessel P002A Pressure Reducing Valve						Supply Contractor	Mech. Contractor		I112	WP-P0013			
0723	O	PI-P002B	Pressure Indicator	DAF Saturator Vessel P002A Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0013			
0724	O	PS-P002A	Pressure Switch	DAF Saturator Vessel P002A Pressure Low						Supply Contractor	Mech. Contractor		I115	WP-P0013			
0725	O	SOL-P002A	Solenoid Actuator	DAF Saturator Vessel P002A Outlet Flow Shutoff Valve Actuator						Supply Contractor	Mech. Contractor			WP-P0013			
0726	O	TT-P002A	Temperature Indicator Transmitter	DAF Saturator Vessel P002A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0013			
0727	O	TE-P002A	Temperature Element	DAF Saturator Vessel P002A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0013			
0728	O	FT-P003A	Flow Indicator Transmitter	DAF Recycle Water Flow to Saturator P003A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0015	WB-A0453	WB-A0402	WP-M0207
0729	O	FE-P003A	Flow Element	DAF Recycle Water Flow to Saturator P003A				0-150 L/s	Flange	Mech. Contractor	Mech. Contractor	250 mm	I100	WP-P0015	WB-A0453	WB-A0453	WP-M0207
0730	O	LT-P003A	Level Indicator Transmitter	DAF Saturator Vessel P003A Level			Loop powered	0-600 mm	Transmitter mounted on bypass level indicator	Supply Contractor	Supply Contractor			WP-P0014	WB-A0465		WP-E0134
0731	O	LE-P003A	Level Element	DAF Saturator Vessel P003A Level					By pass indicator	Supply Contractor	Mech. Contractor			WP-P0014	WB-A0465		WP-E0134
0732	O	LS-P003A	Level Switch	DAF Saturator Vessel P003A Level Low			120V	50.8mm	Flange	Supply Contractor	Mech. Contractor		N/A	WP-P0014	WB-A0463	N/A	WP-E0134
0733	O	PT-P003A	Pressure Indicator Transmitter	DAF Saturator Vessel P003A Pressure			Loop Powered	0-1000 Kpa	Flange	Supply Contractor	Mech. Contractor		I111	WP-P0014	WB-A0465	WB-A0408	
0734	O	PI-P003A	Pressure Indicator	DAF Saturator Vessel P003A Pressure Reducing Valve						Supply Contractor	Mech. Contractor		I112	WP-P0014			
0735	O	PI-P003B	Pressure Indicator	DAF Saturator Vessel P003A Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0014			
0736	O	PS-P003A	Pressure Switch	DAF Saturator Vessel P003A Pressure Low						Supply Contractor	Mech. Contractor		I115	WP-P0014			
0737	O	SOL-P003A	Solenoid Actuator	DAF Saturator Vessel P003A Outlet Flow Shutoff Valve Actuator						Supply Contractor	Mech. Contractor			WP-P0014			
0738	O	TT-P003A	Temperature Indicator Transmitter	DAF Saturator Vessel P003A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0014			
0739	O	TE-P003A	Temperature Element	DAF Saturator Vessel P003A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0014			
0740	O	FT-P004A	Flow Indicator Transmitter	DAF Recycle Water Flow to Saturator P004A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0015	WB-A0453	WB-A0402	WP-M0207
0741	O	FE-P004A	Flow Element	DAF Recycle Water Flow to Saturator P004A				0-150 L/s	Flange	Mech. Contractor	Mech. Contractor	250 mm	I100	WP-P0015	WB-A0453	WB-A0453	WP-M0207
0742	O	LT-P004A	Level Indicator Transmitter	DAF Saturator Vessel P004A Level			Loop powered	0-600 mm	Transmitter mounted on bypass level indicator	Supply Contractor	Supply Contractor			WP-P0014	WB-A0465		WP-E0134
0743	O	LE-P004A	Level Element	DAF Saturator Vessel P004A Level					By pass indicator	Supply Contractor	Mech. Contractor			WP-P0014	WB-A0465		WP-E0134
0744	O	LS-P004A	Level Switch	DAF Saturator Vessel P004A Level Low			120V	50.8mm	Flange	Supply Contractor	Mech. Contractor		N/A	WP-P0014	WB-A0463	N/A	WP-E0134
0745	O	PT-P004A	Pressure Indicator Transmitter	DAF Saturator Vessel P004A Pressure			Loop Powered	0-1000 Kpa	Flange	Supply Contractor	Mech. Contractor		I111	WP-P0014	WB-A0465	WB-A0408	
0746	O	PI-P004A	Pressure Indicator	DAF Saturator Vessel P004A Pressure Reducing Valve						Supply Contractor	Mech. Contractor		I112	WP-P0014			
0747	O	PI-P004B	Pressure Indicator	DAF Saturator Vessel P004A Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0014			
0748	O	PS-P004A	Pressure Switch	DAF Saturator Vessel P004A Pressure Low						Supply Contractor	Mech. Contractor		I115	WP-P0014			
0749	O	SOL-P004A	Solenoid Actuator	DAF Saturator Vessel P004A Outlet Flow Shutoff Valve Actuator						Supply Contractor	Mech. Contractor			WP-P0014			
0750	O	TT-P004A	Temperature Indicator Transmitter	DAF Saturator Vessel P004A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0014			
0751	O	TE-P004A	Temperature Element	DAF Saturator Vessel P004A Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0014			
0752	O	PI-P010F	Pressure Indicator	DAF Recycle Pump P-P010A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209
0753	O	PI-P010G	Pressure Indicator	DAF Recycle Pump P-P010A Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0754	O	TE-P010A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P010A temperature						Supply Contractor	Mech. Contractor			WP-P0012			
0755	O	PI-P020H	Pressure Indicator	DAF Recycle Pump P-P020A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209
0756	O	PI-P020J	Pressure Indicator	DAF Recycle Pump P-P020A Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209
0757	O	TE-P020A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P020A temperature						Supply Contractor	Mech. Contractor			WP-P0012			
0758	O	PI-P030F	Pressure Indicator	DAF Recycle Pump P-P030A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209
0759	O	PI-P030G	Pressure Indicator	DAF Recycle Pump P-P030A Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0012		WB-A0404	WP-M0209
0760	O	TE-P030A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P030A temperature						Supply Contractor	Mech. Contractor			WP-P0012			
0761	O	PI-P040F	Pressure Indicator	DAF Recycle Pump P-P040A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0762	O	PI-P040G	Pressure Indicator	DAF Recycle Pump P-P040A Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0763	O	TE-P040A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P040A temperature						Supply Contractor	Mech. Contractor			WP-P0014			
0764	O	PI-P050H	Pressure Indicator	DAF Recycle Pump P-P050A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0765	O	PI-P050J	Pressure Indicator	DAF Recycle Pump P-P050 Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0766	O	TE-P050A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P050A temperature						Supply Contractor	Mech. Contractor			WP-P0014			
0767	O	PI-P060F	Pressure Indicator	DAF Recycle Pump P-P060A Inlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0768	O	PI-P060G	Pressure Indicator	DAF Recycle Pump P-P060A Outlet Pressure					Pipe	Supply Contractor	Mech. Contractor		I112	WP-P0014		WB-A0404	WP-M0210
0769	O	TE-P060A	DAF Recycle Pump - Thermistor	DAF Recycle Pump P-P060A temperature						Supply Contractor	Mech. Contractor			WP-P0014			
0770	O	FT-P100A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP100A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0002	WB-A0453	WB-A0402	WP-M0201
0771	O	FE-P100A	Flow Element	Raw Water Flow to DAF TNKP100A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0002	WB-A0453	WB-A0453	WA-E0102
0772	O	LT-P100A	Level Indicator Transmitter	DAF TNKP100A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0004	WB-A0455	WB-A0402	WP-E0133
0773	O	LE-P100A	Level Element	DAF TNKP100A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0004	WB-A0455	WB-A0401	WP-E0133
0774	O	SOL-P120A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP100A)						Supply Contractor	Mech. Contractor			WP-P0004			WP-M0131
0775	O	SOL-P120B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP100A)						Supply Contractor	Mech. Contractor			WP-P0004			WP-M0131
0776	O	FT-P200A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP200A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0002	WB-A0453	WB-A0402	WP-M0201
0777	O	FE-P200A	Flow Element	Raw Water Flow to DAF TNKP200A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0002	WB-A0453	WB-A0453	WA-E0102
0778	O	LT-P200A	Level Indicator Transmitter	DAF TNKP200A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0005	WB-A0455	WB-A0402	WP-E0133
0779	O	LE-P200A	Level Element	DAF TNKP200A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0005	WB-A0455	WB-A0401	WP-E0133
0780	O	SOL-P220A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP200A)						Supply Contractor	Mech. Contractor			WP-P0005			WP-M0131
0781	O	SOL-P220B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP200A)						Supply Contractor	Mech. Contractor			WP-P0005			WP-M0131
0782	O	FT-P300A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP300A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0002	WB-A0453	WB-A0402	WP-M0201
0783	O	FE-P300A	Flow Element	Raw Water Flow to DAF TNKP300A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0002	WB-A0453	WB-A0453	WA-E0102
0784	O	LT-P300A	Level Indicator Transmitter	DAF TNKP300A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0006	WB-A0455	WB-A0402	WP-E0133
0785	O	LE-P300A	Level Element	DAF TNKP300A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0006	WB-A0455	WB-A0401	WP-E0133
0786	O	SOL-P320A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP300A)						Supply Contractor	Mech. Contractor			WP-P0006			WP-M0130
0787	O	SOL-P320B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP300A)						Supply Contractor	Mech. Contractor			WP-P0006			WP-M0130
0788	O	FT-P400A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP400A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0002	WB-A0453	WB-A0402	WP-M0201
0789	O	FE-P400A	Flow Element	Raw Water Flow to DAF TNKP400A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0002	WB-A0453	WB-A0453	WA-E0102
0790	O	LT-P400A	Level Indicator Transmitter	DAF TNKP400A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0007	WB-A0455	WB-A0402	WP-E0133
0791	O	LE-P400A	Level Element	DAF TNKP400A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0007	WB-A0455	WB-A0401	WP-E0133
0792	O	SOL-P420A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP400A)						Supply Contractor	Mech. Contractor			WP-P0007			WP-M0130
0793	O	SOL-P420B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP400A)						Supply Contractor	Mech. Contractor			WP-P0007			WP-M0130
0794	O	FT-P500A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP500A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0003	WB-A0453	WB-A0402	WP-M0201

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0795	O	FE-P500A	Flow Element	Raw Water Flow to DAF TNKP500A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0003	WB-A0453	WB-A0453	WA-E0102
0796	O	LT-P500A	Level Indicator Transmitter	DAF TNKP500A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0008	WB-A0455	WB-A0402	WP-E0134
0797	O	LE-P500A	Level Element	DAF TNKP500A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0008	WB-A0455	WB-A0401	WP-E0134
0798	O	SOL-P520A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP500A)						Supply Contractor	Mech. Contractor			WP-P0008			WP-M0130
0799	O	SOL-P520B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP500A)						Supply Contractor	Mech. Contractor			WP-P0008			WP-M0130
0800	O	FT-P600A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP600A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0003	WB-A0453	WB-A0402	WP-M0201
0801	O	FE-P600A	Flow Element	Raw Water Flow to DAF TNKP600A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0003	WB-A0453	WB-A0453	WA-E0102
0802	O	LT-P600A	Level Indicator Transmitter	DAF TNKP600A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0009	WB-A0455	WB-A0402	WP-E0134
0803	O	LE-P600A	Level Element	DAF TNKP600A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0009	WB-A0455	WB-A0401	WP-E0134
0804	O	SOL-P620A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP600A)						Supply Contractor	Mech. Contractor			WP-P0009			WP-M0130
0805	O	SOL-P620B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP600A)						Supply Contractor	Mech. Contractor			WP-P0009			WP-M0130
0806	O	FT-P700A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP700A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0003	WB-A0453	WB-A0402	WP-M0201
0807	O	FE-P700A	Flow Element	Raw Water Flow to DAF TNKP700A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0003	WB-A0453	WB-A0453	WA-E0102
0808	O	LT-P700A	Level Indicator Transmitter	DAF TNKP700A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0010	WB-A0455	WB-A0402	WP-E0134
0809	O	LE-P700A	Level Element	DAF TNKP700A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0010	WB-A0455	WB-A0401	WP-E0134
0810	O	SOL-P720A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP700A)						Supply Contractor	Mech. Contractor			WP-P0010			WP-M0130
0811	O	SOL-P720B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP700A)						Supply Contractor	Mech. Contractor			WP-P0010			WP-M0130
0812	O	FT-P800A	Flow Indicator Transmitter	Raw Water Flow to DAF TNKP800A			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0003	WB-A0453	WB-A0402	WP-M0201
0813	O	FE-P800A	Flow Element	Raw Water Flow to DAF TNKP800A				0-650 L/s	Flange	Mech. Contractor	Mech. Contractor	450 mm	I100	WP-P0003	WB-A0453	WB-A0453	WA-E0102
0814	O	LT-P800A	Level Indicator Transmitter	DAF TNKP800A Level			120V	0-600 mm	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WP-P0011	WB-A0455	WB-A0402	WP-E0134
0815	O	LE-P800A	Level Element	DAF TNKP800A Level					Bracket	Supply Contractor	Mech. Contractor		I120	WP-P0011	WB-A0455	WB-A0401	WP-E0134
0816	O	SOL-P820A	Solenoid Actuator	DAF Basin Headwall Spray Wash Header Valve (TNKP800A)						Supply Contractor	Mech. Contractor			WP-P0011			WP-M0130
0817	O	SOL-P820B	Solenoid Actuator	DAF Basin Float Trough Spray Wash Valve (TNKP800A)						Supply Contractor	Mech. Contractor			WP-P0011			WP-M0130
0818	O	PT-P900A	Pressure Indicator Transmitter	DAF Air Receiver Pressure			Loop Powered	TBC		Mech. Contractor	E&I Contractor		I111	WP-P0015			
0819	O	PS-P910A	Pressure Switch	Air Compressor CMPP910A High Outlet Air Pressure						Supply Contractor	Mech. Contractor		I115	WP-P0015			
0820	O	PI-P910A	Pressure Indicator	Air Compressor CMPP910A Outlet Air Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0821	O	TS-P910A	Temperature Switch	Air Compressor CMPP910A High Outlet Air Temperature						Supply Contractor	Mech. Contractor			WP-P0015			
0822	O	TT-P910A	Temperature Indicator	Air Compressor CMPP910A Outlet Air Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0015			
0823	O	PI-P911A	Pressure Indicator	Air Receiver PV-P910A Pressure						Mech. Contractor	Mech. Contractor		I112	WP-P0015			
0824	O	PI-P911D	Pressure Indicator	Filter Inlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0825	O	PI-P911E	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0826	O	PI-P911F	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0827	O	PI-P911G	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0828	O	PS-P920A	Pressure Switch	Air Compressor CMPP920A High Outlet Air Pressure						Supply Contractor	Mech. Contractor		I115	WP-P0015			
0829	O	PI-P920A	Pressure Indicator	Air Compressor CMPP920A Outlet Air Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0830	O	TS-P920A	Temperature Switch	Air Compressor CMPP920A High Outlet Air Temperature						Supply Contractor	Mech. Contractor			WP-P0015			
0831	O	TT-P920A	Temperature Indicator	Air Compressor CMPP920A Outlet Air Temperature						Supply Contractor	Mech. Contractor		I131	WP-P0015			
0832	O	PI-P921A	Pressure Indicator	Air Receiver PV-P920A Pressure						Mech. Contractor	Mech. Contractor		I112	WP-P0015			
0833	O	PI-P921D	Pressure Indicator	Filter Inlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0834	O	PI-P921E	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0835	O	PI-P921F	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0836	O	PI-P921G	Pressure Indicator	FilterOutlet Pressure						Supply Contractor	Mech. Contractor		I112	WP-P0015			
0837	O	PT-P930A	Pressure Indicator/Level Transmitter	DAF Float Sump P930A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0018	WB-A0465	WB-A0408	WP-M0209

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0838	O	PT-P930B	Pressure Indicator/Level Transmitter	DAF Float Sump P930A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0018	WB-A0465	WB-A0408	WP-M0209
0839	O	PI -P931A	Pressure Indicator	DAF Float Transfer Pump P931A							Mech. Contractor		I112	WP-P0018			
0840	O	PI-P932A	Pressure Indicator	DAF Float Transfer Pump P932A Discharge							Mech. Contractor		I112	WP-P0018			
0841	O	PT-P940A	Pressure Indicator/Level Transmitter	DAF Float Sump P940A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0018	WB-A0465	WB-A0408	WP-M0209
0842	O	PT-P940B	Pressure Indicator/Level Transmitter	DAF Float Sump P940A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0018	WB-A0465	WB-A0408	WP-M0209
0843	O	PI -P941A	Pressure Indicator	DAF Float Transfer Pump P94A1 Discharge							Mech. Contractor		I112	WP-P0018			
0844	O	PI -P942A	Pressure Indicator	DAF Float Transfer Pump P942A Discharge							Mech. Contractor		I112	WP-P0018			
0845	O	PT-P950A	Pressure Indicator/Level Transmitter	DAF Float Sump P950A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0019	WB-A0465	WB-A0408	WP-M0210
0846	O	PT-P950B	Pressure Indicator/Level Transmitter	DAF Float Sump P950A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0019	WB-A0465	WB-A0408	WP-M0210
0847	O	PI -P951A	Pressure Indicator	DAF Float Transfer Pump P951A Discharge							Mech. Contractor		I112	WP-P0019			
0848	O	PI -P952A	Pressure Indicator	DAF Float Transfer Pump P952A Discharge							Mech. Contractor		I112	WP-P0019			
0849	O	PT-P960A	Pressure Indicator/Level Transmitter	DAF Float Sump P960A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0019	WB-A0465	WB-A0408	WP-M0210
0850	O	PT-P960B	Pressure Indicator/Level Transmitter	DAF Float Sump P960A Level			Loop Powered	0-100 Kpa	Flange	E&I Contractor	Mech. Contractor		I111	WP-P0019	WB-A0465	WB-A0408	WP-M0210
0851	O	PI -P961A	Pressure Indicator	DAF Float Transfer Pump P961A Discharge							Mech. Contractor		I112	WP-P0019			
0852	O	PI -P962A	Pressure Indicator	DAF Float Transfer Pump P962A Discharge							Mech. Contractor		I112	WP-P0019			
0853	O	LS-P970A	Level Switch	DAF Effluent Channel West Side (Train 1)			120V	2.4 mtrs from bottom of channel	Flange	E&I Contractor	E&I Contractor		I125	WP-P0017	WB-A0463	WB-A0406	WP-E0133
0854	O	LT-P970A	Level Indicator Transmitter	DAF Effluent Channel West Side (Train 1)			120V	0-5 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WP-P0017	WB-A0455	WB-A0402	WP-E0133
0855	O	LE-P970A	Level Element	DAF Effluent Channel West Side (Train 1)					Flange	E&I Contractor	E&I Contractor		I120	WP-P0017	WB-A0455	WB-A0401	WP-E0133
0856	O	LS-P971A	Level Switch	DAF Effluent Channel East Side (Train 2)			120V	2.4 mtrs from bottom of channel	Flange	E&I Contractor	E&I Contractor		I125	WP-P0017	WB-A0463	WB-A0406	WP-E0134
0857	O	LT-P971A	Level Indicator Transmitter	DAF Effluent Channel East Side (Train 2)			120V	0-5 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WP-P0017	WB-A0455	WB-A0402	WP-E0134
0858	O	LE-P971A	Level Element	DAF Effluent Channel East Side (Train 2)					Flange	E&I Contractor	E&I Contractor		I120	WP-P0017	WB-A0455	WB-A0401	WP-E0134
0859	O	AE-P975A	Turbidity Analyzer	DAF Common Effluent Channel Turbidity					Backboard	E&I Contractor	E&I Contractor			WP-P0017			WP-M0115
0860	O	AT-P975A	Turbidity Indicator Transmitter	DAF Common Effluent Channel Turbidity				3-5 NTU	Backboard	E&I Contractor	E&I Contractor			WP-P0017			WP-M0115
0861	O	FI-P975A	Sample Flow Indicator	DAF Common Effluent Channel Turbidity Sample Flow								Rotameter Complete With Low Flow Switch		WP-P0017			WP-M0115
0862	O	FS-P975A	Flow Switch	DAF Common Effluent Channel Turbidity Low Sample Flow										WP-P0017			
0863		AE-P976A	pH Element	DAF Common Effluent Channel pH					Backboard	E&I Contractor	E&I Contractor			WP-P0017			WP-M0115
0864		AT-P976A	pH Indicator Transmitter	DAF Common Effluent Channel pH				4-8	Backboard	E&I Contractor	E&I Contractor			WP-P0017			WP-M0115
0865	O	LE-P980A	Level Element	DAF Area Process Sump Pump Level					Bracket	E&I Contractor	E&I Contractor		I120	WP-P0020	WB-A0455	WB-A0401	NOD
0866	O	LT-P980A	Level Indicator Transmitter	DAF Area Process Sump Pump Level			120V	0-4 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WP-P0020	WB-A0455	WB-A0402	NOD
0867	O	LE-P980B	Level Element	DAF Area Process Sump Pump Level					Bracket	E&I Contractor	E&I Contractor		I120	WP-P0020	WB-A0455	WB-A0401	NOD
0868	O	LT-P980B	Level Indicator Transmitter	DAF Area Process Sump Pump Level			120V	0-4 m	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WP-P0020	WB-A0455	WB-A0402	NOD
0869	O	FT-P990A	Flow Indicator Transmitter	Sump P930A and Sump P940A Float Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0018	WB-A0453	WB-A0402	WP-M0209
0870	O	FE-P990A	Flow Element	Sump P930A and Sump P940A Float Flow				0-25 L/s	Flange	Mech. Contractor	Mech. Contractor	75 mm	I100	WP-P0018	WB-A0453	WB-A0453	WP-M0209
0871	O	FT-P993A	Flow Indicator Transmitter	Sump P950A and Sump P960A Float Flow			120V		Wall/Stand	Mech. Contractor	E&I Contractor		I100	WP-P0019	WB-A0453	WB-A0402	WP-M0209
0872	O	FE-P993A	Flow Element	Sump P950A and Sump P960A Float Flow				0-25 L/s	Flange	Mech. Contractor	Mech. Contractor	75 mm	I100	WP-P0019	WB-A0453	WB-A0453	WP-M0209
0873	O	AE-R001A	Suspended Solids Monitor	Washwater Recovery Tanks Sludge to Flocculation Chamber Suspended Solids Monitor					In Line	E&I Contractor	E&I Contractor		I160	WR-P0006	WB-A0462	WB-A0410	WR-E0401
0874	O	AT-R001A	Suspended Solids Analyzer	Washwater Recovery Tanks Sludge to Flocculation Chamber Suspended Solids Monitor			120V	0-50 g/l	Wall/Stand	E&I Contractor	E&I Contractor		I160	WR-P0006	WB-A0462	WB-A0410	WR-E0401
0875	O	FT-R001B	Flow Indicator Transmitter	Washwater Recovery Tanks Sludge to Flocculation Chamber Flow			120V		Wall/Stand	Mech Contractor	E&I Contractor		I100	WR-P0006	WB-A0453	WB-A0402	WR-E0122
0876	O	FE-R001B	Flow Element	Washwater Recovery Tanks Sludge to Flocculation Chamber Flow				0-2500 l/m	Flange	Mech Contractor	Mech Contractor	150 mm	I100	WR-P0006	WB-A0453	WB-A0453	WR-E0122

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0877	O	LS-R001A	Multiple Point Conductivity Level Switch	Flocculation Chamber Level Switch			120V	Low setpoint 0.1 mtr from bottom of chamber High setpoint 0.94 mtrs from bottom of chamber High high setpoint 1.1 mtrs from bottom of chamber	Bracket	E&I Contractor	E&I Contractor		I126	WR-P0006	WB-A0458	N/A	WR-E0401
0878	O	LY-R001A	Level Relay	Flocculation Chamber Low Level Relay			120V		Junction Box	E&I Contractor	E&I Contractor	Relays mounted in local junction box		WR-P0006			WR-E0401
0879	O	LY-R001B	Level Relay	Flocculation Chamber High Level Relay			120V		Junction Box	E&I Contractor	E&I Contractor	Relays mounted in local junction box		WR-P0006			WR-E0401
0880	O	LY-R001C	Level Relay	Flocculation Chamber High High Level Relay			120V		Junction Box	E&I Contractor	E&I Contractor	Relays mounted in local junction box		WR-P0006			WR-E0401
0881	O	PI-R001A	Pressure Indicator	Washwater Recovery Tanks Sludge to Flocculation Chamber Pressure				0-150 Kpa		Mech Contractor	Mech Contractor		I112	WR-P0006			
0882	O	AE-R010A	Suspended Solids Monitor	Washwater Recovery Tank Supernatent Suspended Solids Monitor					In Line	E&I Contractor	E&I Contractor		I160	WR-P0006	WB-A0462	WB-A0410	WR-E0401
0883	O	AT-R010A	Suspended Solids Analyzer	Washwater Recovery Tank Supernatent Suspended Solids Monitor			120V	0-50 g/l	Wall/ Stand	E&I Contractor	E&I Contractor		I160	WR-P0006	WB-A0462	WB-A0410	WR-E0401
0884	O	FI-R010A	Flow Indicator	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump Outlet Flow						Mech Contractor	Mech Contractor	Rotameter Complete With Low Flow Switch		WR-P0006			WR-E0401
0885	O	FS-R010A	Flow Switch	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump Outlet Flow Switch			120V							WR-P0006			WR-E0401
0886	O	LS-R010A	Conductivity Level Switch	Washwater Recovery Tank Inlet Channel High Level			120V	1.05 mtrs from floor of channel	Flange	E&I Contractor	E&I Contractor	Mounted to monitor flow over the weir	I126	WR-P0001	WB-A0458	N/A	WR-E0122
0887	O	LS-R010B	Conductivity Level Switch	Washwater Recovery Tank Inlet Channel High Level			120V	1.05 mtrs from floor of channel	Flange	E&I Contractor	E&I Contractor	Mounted to monitor flow over the weir	I126	WR-P0001	WB-A0458	N/A	WR-E0123
0888	O	SP-R010A	Sample Pump	Washwater Recovery Tank Supernatent Suspended Solids Monitor Sample Pump			120V	To suit required sample flow rate	Floor	Mech Contractor	Mech Contractor			WR-P0006			WR-E0401
0889	O	LS-R020A	Level Switch	Supernatent Pump Station Low Low Level			120V	2.25 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0007	WB-A0463	WB-A0406	WR-E0401
0890	O	LS-R020B	Level Switch	Supernatent Pump Station High High Level			120V	7.4 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0007	WB-A0463	WB-A0406	WR-E0401
0891	O	LT-R020A	Level Indicator Transmitter	Supernatent Pump Station Level			120V	0-8.5 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0007	WB-A0455	WB-A0402	WR-E0401
0892	O	LE-R020A	Level Element	Supernatent Pump Station Level					Bracket	E&I Contractor	E&I Contractor		I120	WR-P0007	WB-A0455	WB-A0401	WR-E0401
0893	O	LS-R020C	Multiple Point Conductivity Level Switch	Overflow Channel Level Switch			120V	High setpoint 0.74 mtrs from bottom of chamber High high setpoint 0.84 mtrs from bottom of chamber	Flange	E&I Contractor	E&I Contractor		I126	WR-P0007	WB-A0458		WR-E0122
0894		LS-R020D	Multiple Point Conductivity Level Switch	Overflow Channel Level Switch			120V	High setpoint 0.74 mtrs from bottom of chamber High high setpoint 0.84 mtrs from bottom of chamber	Flange	E&I Contractor	E&I Contractor		I126	WR-P0007	WB-A0458		WR-E0122
0895	O	AE-R021B	Reverse Spin Relay	Supernatent Pump P-R021A Reverse Spin Relay										WR-P0007			WR-E0401
0896	O	ST-R021A	Speed Indicator Transmitter	Supernatent Pump P-R021A Speed Indicator Transmitter										WR-P0007			
0897	O	SOL-R021B	Solenoid Actuator	Supernatent Pump P-R021A Outlet Control Valve Solenoid Operator										WR-P0007			
0898	O	TT-R021B	Temperature Transmitter	Supernatent Pump P-R021A Winding Temperature									I131	WR-P0007			
0899	O	TT-R021C	Temperature Indicator Transmitter	Supernatent Pump P-R021A Bottom Bearing Temperature									I131	WR-P0007			
0900	O	TT-R021D	Temperature Indicator Transmitter	Supernatent Pump P-R021A Top Bearing Temperature									I131	WR-P0007			
0901	O	VT-R021A	Vibration Transmitter	Supernatent Pump P-R021A Vibration Sensor/ Transmitter										WR-P0007			
0902	O	AE-R022B	Reverse Spin Relay	Supernatent Pump P-R022A Reverse Spin Relay										WR-P0007			WR-E0401
0903	O	ST-R022A	Speed Indicator Transmitter	Supernatent Pump P-R022A Speed Indicator Transmitter										WR-P0007			
0904	O	SOL-R022B	Solenoid Actuator	Supernatent Pump P-R022A Outlet Control Valve Solenoid Operator										WR-P0007			
0905	O	TT-R022B	Temperature Indicator Transmitter	Supernatent Pump P-R022A Winding Temperature									I131	WR-P0007			
0906	O	TT-R022C	Temperature Indicator Transmitter	Supernatent Pump P-R022A Bottom Bearing Temperature									I131	WR-P0007			
0907	O	TT-R022D	Temperature Indicator Transmitter	Supernatent Pump P-R022A Top Bearing Temperature									I131	WR-P0007			
0908	O	VS-R022A	Vibration Transmitter	Supernatent Pump P-R022A Vibration Sensor/ Transmitter										WR-P0007			

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0909	O	AE-R023B	Reverse Spin Relay	Supernatent Pump P-R023A Reverse Spin Relay										WR-P0007			WR-E0401
0910	O	SOL-R023B	Solenoid Actuator	Supernatent Pump P-R023A Outlet Control Valve Solenoid Operator										WR-P0007			
0911	O	TT-R023B	Temperature Indicator Transmitter	Supernatent Pump P-R023A Winding Temperature									I131	WR-P0007			
0912	O	TT-R023C	Temperature Indicator Transmitter	Supernatent Pump P-R023A Bottom Bearing Temperature									I131	WR-P0007			
0913	O	TT-R023D	Temperature Indicator Transmitter	Supernatent Pump P-R022A Top Bearing Temperature									I131	WR-P0007			
0914	O	VT-R023A	Vibration Switch	Supernatent Pump P-R023A Vibration Sensor/ Transmitter										WR-P0007			
0915	O	AE-R024A	Turbidity/ TSS Monitor	Supernatent Pump Station Outlet Turbidity/TSS										WR-P0007			WR-E0401
0916	O	AT-R024A	Turbidity/ TSS Analyzer	Supernatent Pump Station Outlet Turbidity/TSS										WR-P0007			WR-E0401
0917		FE-R024A	Flow Element	Supernatent Pump Station Outlet Flow				0-3500 l/m	Flange	Mech Contractor	Mech Contractor		I100	WR-P0007	WB-A0453	WB-A0453	
0918		FT-R024A	Flow Indicator Transmitter	Supernatent Pump Station Outlet Flow			120V		Wall/Stand	Mech Contractor	E&I Contractor	600mm	I100	WR-P0007	WB-A0453	WB-A0402	
0919	O	PI-R024A	Pressure Indicator	Supernatent Pump Station Outlet Pressure									I112	WR-P0007			
0920	O	SOL-R024B	Solenoid Valve	Supernatent Pump Station Pump Control Valve Solenoid Operator										WR-P0007			
0921	O	LS-R100A	Level Switch	Washwater Recovery Tank WRTR100A Low Low Level			120V	6.2 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0002	WB-A0463	WB-A0406	WR-E0401
0922	O	LS-R100B	Level Switch	Washwater Recovery Tank WRTR100A High High Level			120V	2.1 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0002	WB-A0463	WB-A0406	WR-E0401
0923	O	LT-R100D	Level Indicator Transmitter	Washwater Recovery Tank WRTR100A Level			120V	0-6 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0002	WB-A0455	WB-A0402	WR-E0401
0924	O	LE-R100D	Level Element	Washwater Recovery Tank WRTR100A Level					Flange	E&I Contractor	E&I Contractor		I120	WR-P0002	WB-A0455	WB-A0401	WR-E0401
0925	O	LT-R100E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level			120V	0-4000NTU 0-50 g/l	Wall/ Stand	E&I Contractor	E&I Contractor		I160	WR-P0002	WB-A0462	WB-A0410	WR-E0122
0926	O	LE-R100E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level					In Liquid	E&I Contractor	E&I Contractor		I160	WR-P0002	WB-A0462	WB-A0410	WR-E0122
0927	O	LS-R200A	Level Switch	Washwater Recovery Tank WRTR200A Low Low Level			120V	6.2 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0003	WB-A0463	WB-A0406	WR-E0401
0928	O	LS-R200B	Level Switch	Washwater Recovery Tank WRTR200A High High Level			120V	2.1 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0003	WB-A0463	WB-A0406	WR-E0401
0929	O	LT-R200D	Level Indicator Transmitter	Washwater Recovery Tank WRTR200A Level			120V	0-6 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0003	WB-A0455	WB-A0402	WR-E0401
0930	O	LE-R200D	Level Element	Washwater Recovery Tank WRTR200A Level					Flange	E&I Contractor	E&I Contractor		I120	WR-P0003	WB-A0455	WB-A0401	WR-E0401
0931	O	LT-R200E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level			120V	0-4000NTU 0-50 g/l	Wall/ Stand	E&I Contractor	E&I Contractor		I160	WR-P0003	WB-A0462	WB-A0410	WR-E0122
0932	O	LE-R200E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level					In Liquid	E&I Contractor	E&I Contractor		I160	WR-P0003	WB-A0462	WB-A0410	WR-E0122
0933	O	LS-R300A	Level Switch	Washwater Recovery Tank WRTR300A Low Low Level			120V	6.2 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0004	WB-A0463	WB-A0406	WR-E0401
0934	O	LS-R300B	Level Switch	Washwater Recovery Tank WRTR300A High High Level			120V	2.1 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0004	WB-A0463	WB-A0406	WR-E0401
0935	O	LT-R300D	Level Indicator Transmitter	Washwater Recovery Tank WRTR300A Level			120V	0-6 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0004	WB-A0455	WB-A0402	WR-E0401
0936	O	LE-R300D	Level Element	Washwater Recovery Tank WRTR300A Level					Flange	E&I Contractor	E&I Contractor		I120	WR-P0004	WB-A0455	WB-A0401	WR-E0401
0937	O	LT-R300E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level			120V	0-4000NTU 0-50 g/l	Wall/ Stand	E&I Contractor	E&I Contractor		I160	WR-P0004	WB-A0462	WB-A0410	WR-E0122
0938	O	LE-R300E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level					In Liquid	E&I Contractor	E&I Contractor		I160	WR-P0004	WB-A0462	WB-A0410	WR-E0122
0939	O	LS-R400A	Level Switch	Washwater Recovery Tank WRTR400A Low Low Level			120V	6.2 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0005	WB-A0463	WB-A0406	WR-E0401
0940	O	LS-R400B	Level Switch	Washwater Recovery Tank WRTR400A High High Level			120V	2.1 mtrs from slab	Flange	E&I Contractor	E&I Contractor		I125	WR-P0005	WB-A0463	WB-A0406	WR-E0401
0941	O	LT-R400D	Level Indicator Transmitter	Washwater Recovery Tank WRTR400A Level			120V	0-6 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0005	WB-A0455	WB-A0402	WR-E0401
0942	O	LE-R400D	Level Element	Washwater Recovery Tank WRTR400A Level					Flange	E&I Contractor	E&I Contractor		I120	WR-P0005	WB-A0462	WB-A0410	WR-E0401
0943	O	LT-R400E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level			120V	0-4000NTU 0-50 g/l	Wall/ Stand	E&I Contractor	E&I Contractor		I160	WR-P0005	WB-A0462	WB-A0410	WR-E0122
0944	O	LE-R400E	Turbidity/TSS Monitor	Washwater Recovery Tank WRTR100A Turbidity/TSS Level					In Liquid	E&I Contractor	E&I Contractor		I160	WR-P0005	WB-A0462	WB-A0410	WR-E0122
0945	O	AE-R500B	TSS Analyser Sensor	Gravity Thickener GT500A TSS										WR-P0008			
0946	O	AT-R500B	TSS Analyser Indicator Transmitter	Gravity Thickener GT500A TSS										WR-P0008			
0947	O	AE-R500C	Turbidity Analyser Sensor	Gravity Thickener GT500A Turbidity										WR-P0008			
0948	O	AT-R500C	Turbidity Analyser Indicator Transmitter	Gravity Thickener GT500A Turbidity										WR-P0008			
0949	O	LS-R500A	Level Switch	Gravity Thickener GT500A High Level			120V	6.8 mtrs from bottom of tank	Bracket	E&I Contractor	E&I Contractor		I125	WR-P0008	WB-A0463	WB-A0406	WR-E0401
0950	O	VS-R500A	Torque Switch	Gravity Thickener GT500A High Torque Switch										WR-P0008			
0951	O	AE-R600B	TSS Analyser Sensor	Gravity Thickener GT600A TSS										WR-P0008			WR-E0401
0952	O	AT-R600B	TSS Analyser Indicator Transmitter	Gravity Thickener GT600A TSS										WR-P0008			WR-E0401
0953	O	AE-R600C	Turbidity Analyser Sensor	Gravity Thickener GT600A Turbidity										WR-P0008			WR-E0401
0954	O	AT-R600C	Turbidity Analyser Indicator Transmitter	Gravity Thickener GT600A Turbidity										WR-P0008			WR-E0401
0955	O	LS-R600A	Level Switch	Gravity Thickener GT600A High Level			120V	6.8 mtrs from bottom of tank	Bracket	E&I Contractor	E&I Contractor		I125	WR-P0008	WB-A0463	WB-A0406	WR-E0401

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RECORD NO.	REV. No.	TAG NAME	DESCRIPTION		MANUFACTURER	MODEL	POWER SUPPLY	CALIBRATED RANGE	MOUNTING	SUPPLIED BY	INSTALLED BY	COMMENTS	SPEC. DATA SHEET	P&ID DRAWING	INSTRUMENT LOOP DIA.	INSTALLATION DETAIL	LOCATION DWG.
			INSTRUMENT TYPE	SERVICE													
0956	O	VS-R600A	Torque Switch	Gravity Thickener GT600A High Torque Switch										WR-P0008			
0957	O	LE-R710D	Level Element	Thickened Sludge Tank TKR710 Level						E&I Contractor	E&I Contractor		I120	WR-P0009	WB-A0455	WB-A0401	WR-E0401
0958	O	LT-R710D	Level Indicator Transmitter	Thickened Sludge Tank TKR710 Level			120V	0-8.3 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0009	WB-A0455	WB-A0402	WR-E0401
0959	O	LS-R710A	Level Switch	Thickened Sludge Tank TKR710 Low Low Level			120V	1.4 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0009	WB-A0463	WB-A0406	WR-E0401
0960	O	LS-R710B	Level Switch	Thickened Sludge Tank TKR710 High High Level			120V	8 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0009	WB-A0463	WB-A0406	WR-E0401
0961	O	LE-R720D	Level Element	Thickened Sludge Tank TKR720 Level						E&I Contractor	E&I Contractor		I120	WR-P0009	WB-A0455	WB-A0401	WR-E0401
0962	O	LT-R720D	Level Indicator Transmitter	Thickened Sludge Tank TKR720 Level			120V	0-8.3 mtrs	Wall/ Stand	E&I Contractor	E&I Contractor		I120	WR-P0009	WB-A0455	WB-A0402	WR-E0401
0963	O	LS-R720A	Level Switch	Thickened Sludge Tank TKR720 Low Low Level			120V	1.4 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0009	WB-A0463	WB-A0406	WR-E0401
0964	O	LS-R720B	Level Switch	Thickened Sludge Tank TKR720 High High Level			120V	8 mtrs from bottom of tank	Flange	E&I Contractor	E&I Contractor		I125	WR-P0009	WB-A0463	WB-A0406	WR-E0401
0965	O	AE-R730B	TSS Analyser Sensor	Thickened Sludge to Freeze Thaw Ponds TSS										WR-P0009			WR-E0401
0966	O	AT-R730B	TSS Analyser Indicator Transmitter	Thickened Sludge to Freeze Thaw Ponds TSS										WR-P0009			WR-E0401
0967	O	FE-R730A	Flow Element	Thickened Sludge to Freeze Thaw Ponds Flow				0-1400 l/m	Flange	Mech Contractor	Mech Contractor	100 mm	I100	WR-P0009	WB-A0453	WB-A0453	WR-E0122
0968	O	FT-R730A	Flow Indicator Transmitter	Thickened Sludge to Freeze Thaw Ponds Flow			120V		Wall/Stand	Mech Contractor	E&I Contractor		I100	WR-P0009	WB-A0453	WB-A0402	WR-E0122
0969	O	PI-R730	Pressure Indicator	Thickened Sludge to Freeze Thaw Ponds Pressure									I112	WR-P0009			
0970	O	SOL-R730A	Solenoid Valve	Thickened Sludge to Freeze Thaw Ponds Pump Outlet Control Valve Solenoid Operator										WR-P0009			
0971	O	AT-R924A	TSS Analyser Indicator Transmitter	Combined Dewatering Pump Outlet TSS								Included in Freeze/ Thaw ponds contract		WL-P0002			
0972	O	AE-T101A	Analyser Sensor	Clearwell Inlet Combined Ammonia, Total/ Combined Chlorine and Free Chlorine Analyzer										WT-P0001			
0973	O	AT-T101A	Analyser Indicator Transmitter	Clearwell Inlet Combined Ammonia, Total/ Combined Chlorine and Free Chlorine Analyzer										WT-P0001			
0974	O	FI-T101A	Flow Indicator	Clearwell Analyser Sample Flow										WT-P0001			
0975	O	FS-T101A	Flow Switch	Clearwell Analyser Sample Low Flow										WT-P0001			
0976	O	LE-T101A	Level Element	Clearwell Cell No.1 Level					Flange	E&I Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0401	
0977	O	LT-T101A	Level Indicator Transmitter	Clearwell Cell No.1 Level			120V	0-6.2 mtrs	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0402	
0978	O	LE-T101B	Level Element	Clearwell Cell No.1 Level					Flange	E&I Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0401	
0979	O	LT-T101B	Level Indicator Transmitter	Clearwell Cell No.1 Level			120V	0-6.2 mtrs	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0402	
0980	O	SP-T101A	Sample Pump	Clearwell Analyser Sample										WT-P0001			
0981	O	AE-T102A	Analyser Sensor	Clearwell Inlet pH Analyzer										WT-P0001			
0982	O	AT-T102A	Analyser Indicator Transmitter	Clearwell Inlet pH Analyzer										WT-P0001			
0983	O	AE-T103A	Analyser Sensor	Clearwell Inlet Turbidity Analyzer										WT-P0001			
0984	O	AT-T103A	Analyser Indicator Transmitter	Clearwell Inlet Turbidity Analyzer										WT-P0001			
0985	O	AE-T201A	Analyser Sensor	Clearwell Inlet Combined Ammonia, Total/ Combined Chlorine and Free Chlorine Analyzer										WT-P0001			
0986	O	AT-T201A	Analyser Indicator Transmitter	Clearwell Inlet Combined Ammonia, Total/ Combined Chlorine and Free Chlorine Analyzer										WT-P0001			
0987	O	FI-T201A	Flow Indicator	Clearwell Analyser Sample Flow										WT-P0001			
0988	O	FS-T201A	Flow Switch	Clearwell Analyser Sample Low Flow										WT-P0001			
0989	O	LE-T201A	Level Element	Clearwell Cell No.2 Level					Flange	E&I Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0401	
0990	O	LT-T201A	Level Indicator Transmitter	Clearwell Cell No.2 Level			120V	0-6.2 mtrs	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0402	
0991	O	LE-T201B	Level Element	Clearwell Cell No.2 Level					Flange	E&I Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0401	
0992	O	LT-T201B	Level Indicator Transmitter	Clearwell Cell No.2 Level			120V	0-6.2 mtrs	Wall/ Stand	Supply Contractor	E&I Contractor		I120	WT-P0001	WB-A0455	WB-A0402	
0993	O	SP-T201A	Sample Pump	Clearwell Analyser Sample										WT-P0001			
0994	O	AE-T202A	Analyser Sensor	Clearwell Inlet pH Analyzer										WT-P0001			
0995	O	AT-T202A	Analyser Indicator Transmitter	Clearwell Inlet pH Analyzer										WT-P0001			
0996	O	AE-T203A	Analyser Sensor	Clearwell Inlet Turbidity Analyzer										WT-P0001			
0997	O	AT-T203A	Analyser Indicator Transmitter	Clearwell Inlet Turbidity Analyzer										WT-P0001			

INSTRUMENT SPECIFICATION SHEETS

1. GENERAL

1.1 References - General

.1 The Work includes the provision of all instrument specification sheets.

.2 Refer to Section 17010 – Instrumentation and Control General Requirements for general instrumentation and control requirements related to instrument specification sheets.

1.2 Instrument Specification Sheets

.1 Provide data sheets to itemize detailed as-built information regarding the specification of instruments included as part of this Work for each instrument supplied. The data sheets already included in this Section list specific minimum requirements for particular applications.

.2 Use forms in accordance with the ISA Standard S20 as a template for the preparation of the specification sheets.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I100
DEVICE:	Magnetic Flow Meter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
SIZE AND MATERIAL:	Refer to Process Drawings for flow meter size and piping materials
END CONNECTIONS:	Flanged
LINER MATERIAL:	PFA unless otherwise stated in the Instrument List
ELECTRODES:	316 SS Bullet Nose; Hastelloy C-276 in acid lines.
GROUNDING:	316 SS Grounding Rings
RANGE:	Refer to Process Drawings and/or Instrument Lists
INACCURACY:	±1% of span
OUTPUT:	4 to 20 mADC into 500 ohm load Scaled pulse output
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local indication of flow rate and totalized flow
ELECTRONIC ENCLOSURE:	NEMA 4X. Remote wall-mount.
MANUFACTURER AND MODEL:	Rosemount 8700 Series ABB Magmaster Krohne Endress and Hauser.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I101
DEVICE:	Thermal Mass Air Flow Element and Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS PRESSURE:	Refer to Instrument Index, Section 17700
OUTPUT:	4 to 20 mA DC
DISPLAY:	8 Digit flow rate and totalized flow
POWER SUPPLY:	120 VAC, 60 Hz, 1 Ph
CONSTRUCTION:	Stainless steel
ELECTRONICS ENCLOSURE:	NEMA 4
MOUNTING:	Flanged sensor body with remote surface mounted transmitter
ACCESSORIES:	30 m Signal Cable
MANUFACTURER AND MODEL:	ABB Brooks

INSTRUMENT SPECIFICATION NUMBER:	I102
DEVICE:	Compact Inline Flowmeter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS FLOW:	Refer to Instrument Index, Section 17700
OUTPUT:	4 to 20 mA DC
ACCURACY	<3%
REPEATABILITY	<1%
POWER SUPPLY:	24V DC max 100 mA
FLOWTUBE MATERIAL:	To suit liquid being measured, size as shown on drawings
ELECTRONICS ENCLOSURE:	IP65
MOUNTING:	Inline sensor pipe
ACCESSORIES:	2 m moulded oilflex cable
MANUFACTURER AND MODEL:	Weber flow captor

INSTRUMENT SPECIFICATION NUMBER:	I105
DEVICE:	Flow Switch
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Thermal Dispersion
SERVICE:	Refer to Instrument Index and P&ID Diagrams
RANGE:	Refer to Instrument Index, Section 17700
REPEATABILITY:	<1%
OUTPUT:	SPDT contacts rated 10 Amps @ 120 VAC
POWER SUPPLY:	120 VAC, 60 Hz, 1 ∅
ENCLOSURE:	Polymer-coated aluminum, NEMA 4X rating
MOUNTING:	¾" NPT with 1" insertion length
MANUFACTURER AND MODEL:	IFM Weber

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I110
DEVICE:	Differential Pressure Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS CONNECTIONS:	½" NPTF
RANGE:	Refer to Instrument Index, Section 17700
INACCURACY:	±1% of span
OUTPUT:	4 to 20 mADC into 500 ohm
POWER SUPPLY:	Loop powered 24 VDC
CONSTRUCTION:	Stainless steel wetted parts
ELECTRONIC ENCLOSURE:	NEMA 4X
ACCESSORIES:	Anderson Greenwood Stainless steel 3 valve manifold
MANUFACTURER AND MODEL:	Rosemount Model 3051 ABB Foxboro

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I111
DEVICE:	Pressure Transmitter (Gage and Absolute)
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS CONNECTIONS:	½" NPTF
RANGE:	Refer to Instrument Index, Section 17700
INACCURACY:	±1% of span
OUTPUT:	4 to 20 mADC into 500 ohm
POWER SUPPLY:	Loop powered 24 VDC
CONSTRUCTION:	Stainless steel wetted parts
ELECTRONIC ENCLOSURE:	NEMA 4X
ACCESSORIES:	Stainless steel block and bleed manifold
MANUFACTURER AND MODEL:	Rosemount Model 3051 ABB Foxboro

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I112
DEVICE:	Pressure Gauge
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS CONNECTION:	6.35 mm bottom connection
CASE:	75 mm stainless steel complete with stainless steel wetted parts
ACCURACY:	±1% of span
RANGE:	Refer to Instrument Index, Section 17700
ACCESSORIES:	Stainless steel snubber and shut-off cock
MANUFACTURER AND MODEL:	Ashcroft H.O. Trerice Budenberg

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I115
DEVICE:	Pressure Switch
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
PROCESS CONNECTION:	½" NPTF
SENSOR:	Brass Bellows
RANGE:	Refer to Instrument Index, Section 17700
MOUNTING:	Bottom, Stem mounted
ENCLOSURE:	NEMA 4X
OUTPUT:	Form C Contacts rated 5 amps @ 120 VAC
MANUFACTURER AND MODEL:	Ashcroft United Electric Barksdale

INSTRUMENT SPECIFICATION NUMBER:	I116
DEVICE:	Differential Pressure Switch
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Clogged air filter detection
RANGE:	Refer to Instrument Index, Section 17700, with adjustable trip point
PROCESS CONNECTIONS	Barbed tube fittings on switch and static pressure probes.
INACCURACY:	±1.0% of span or better
OUTPUT:	Form C dry contact rated for pilot duty
POWER SUPPLY:	N/A
ENCLOSURE:	Manufacturer's standard
MOUNTING:	Direct mount static pressure probes to the duct. Wall mount bracket for the switch body.
ACCESSORIES:	Wall mount bracket. 5 mm copper sensing lines.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I120
DEVICE:	Liquid Level Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Ultrasonic
SERVICE:	Refer to Instrument Index and P&ID Diagrams
RANGE:	Refer to Instrument Index, Section 17700
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC into 500 ohm load 5 configurable alarm relays
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	NEMA 4X Transmitter Housing NEMA 4X Sensor
MOUNTING:	
(TRANSMITTER)	Wall Mount
(SENSOR)	Provide PVC pipe stilling well where shown on the drawings and in accordance with manufacturer's recommendations to ensure stable readings in turbulent locations. Mount sensor on stilling well. Install sensors at least 300 mm above maximum liquid level. Provide PVC blind flange for mounting sensor.
ACCESSORIES:	1 - hand-held programmer
MANUFACTURER AND MODEL:	Siemens Multiranger 100/200 Magnetrol Endress & Hauser

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I122
DEVICE:	Sludge Blanket Level Transducer and Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Ultrasonic
SERVICE:	Refer to Instrument Index and P&ID Diagrams
RANGE:	Refer to Instrument Index, Section 17700
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC into 500 ohm load Minimum of 2 configurable alarm relays
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	NEMA 4X Transmitter Housing NEMA 6 Transducer
MOUNTING:	
(TRANSMITTER)	Wall Mount
(SENSOR)	Install sensors at least 300 mm above maximum liquid level. Provide PVC blind flange for mounting sensor.
ACCESSORIES:	Transducer to be equipped with a self cleaning mechanism
MANUFACTURER AND MODEL:	Partech Hach Siemens Cerlic

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I125
DEVICE:	Float Switch
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
OUTPUT:	SPDT Contacts
ENCLOSURE:	Polypropylene float casing with preterminated signal cable
MOUNTING:	Provide strain relief-type connectors to suspend float at desired location. Fabricate mounting brackets from 316 SS. Provide anti-sway rings to prevent sway in turbulent tanks.
MANUFACTURER AND MODEL:	Flygt ENM-10 Consolidated Electric Warwick Magnetrol

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I126
DEVICE:	Conductivity Level Switch
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
RANGE:	4 conductivity measuring ranges selectable via dip switches
OUTPUT:	SPDT Contacts
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	PBT Housing; Polypropylene rod insulation
MOUNTING:	Provide PVC blind flange for mounting probes.
MANUFACTURER AND MODEL:	Endress & Hauser

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I130
DEVICE:	Temperature Indicating Transmitter with RTD Sensor
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Ambient Air
RANGE:	0°C to 50°C
INACCURACY:	±0.5% of span
INDICATION:	3½ Digit LED display scaled in engineering units
OUTPUT:	4 to 20 mA DC into 500 ohm load
POWER SUPPLY:	Loop powered
ENCLOSURE:	Transmitter: NEMA 4X RTD Probe: 5 mm dia x 100 mm L ambient air probe
MOUNTING:	Wall mounting
MANUFACTURER AND MODEL:	Rosemount Type 3044C ABB Foxboro

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I131
DEVICE:	Temperature Indicating Transmitter with RTD Sensor
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Process Water
RANGE:	0 - 100°C
INACCURACY:	±0.5% of span
INDICATION:	3½ Digit LED display scaled in engineering units
OUTPUT:	4 to 20 mA DC into 500 ohm load
POWER SUPPLY:	Loop powered
ENCLOSURE:	Transmitter: NEMA 4X RTD Probe: Platinum 100 OHM Spring Loaded
MOUNTING:	Direct to process, use a thermowell with 50 mm insertion at a pipe tee or elbow fitting
MANUFACTURER AND MODEL:	Rosemount Type 3044C ABB Foxboro

INSTRUMENT SPECIFICATION NUMBER:	I132
DEVICE:	Water Temperature Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Heating/Cooling Loop Temperature
RANGE:	0 to 100°C
PROCESS CONNECTION:	3/4" NPT Thermowell with 75 mm insertion
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
ENCLOSURE:	NEMA 4
MOUNTING:	Direct to process, locate at tee or elbow in system.

INSTRUMENT SPECIFICATION NUMBER:	I133
DEVICE:	Outdoor Air Temperature Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Platinum RTD Sensor with Transmitter
RANGE:	-40 to 50°C
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
ENCLOSURE:	Stainless steel temperature probe and weatherproof electronics enclosure.
ACCESSORIES:	Wall mount bracket

INSTRUMENT SPECIFICATION NUMBER:	I134
DEVICE:	Duct Averaging Temperature Transmitter
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Platinum RTD Sensor with Transmitter
SERVICE:	Air handling units
RANGE:	-40 to 50°C
INACCURACY:	±0.5% of span
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
ENCLOSURE:	Manufacturer's standard
ACCESSORIES:	Duct mounting kit with sensor element holder

INSTRUMENT SPECIFICATION NUMBER:	I135
DEVICE:	Thermometer
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Gas Filled or Bimetal Dial Thermometer
SERVICE:	Refer to Instrument Index, Section 17700
RANGE:	-40°C to +50°C
INACCURACY:	±1% or better
CONSTRUCTION:	Stainless Steel
MOUNTING:	½" NPT Thermowell with 200 mm insertion
MANUFACTURER AND MODEL:	H.O. Trerice Co. Taylor Weiss

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I136
DEVICE:	Room Thermostat
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Ambient Air
RANGE:	0 to 60°C
INACCURACY:	±0.5% of span or better
OUTPUT:	Form C dry contacts. Rated 10A@120 VAC resistive.
ENCLOSURE:	Manufacturer's standard
MOUNTING:	Wall mount

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I137
DEVICE:	Heating Coil Freeze-Stat
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Duct Averaging Vapor-Charged Capillary
SERVICE:	Air handling units
RANGE:	-9.4 to 12.8°C
SETPOINT:	1.6°C trip with manual reset
OUTPUT:	1 N.O. and 1 N.C. contact with pilot duty rating
POWER SUPPLY:	N/A
ENCLOSURE:	Manufacturer's standard
ACCESSORIES:	Duct mounting kit with sensor element holder

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I140
DEVICE:	Humidity & Temperature Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Ambient Air Temperature Transmitter with built-in Humidity Transmitter.
RANGE:	0°C to 50°C
DISPLAY:	Three digit LED display with one decimal point.
OUTPUT:	4 to 20 mA DC Humidity 4 to 20 mA DC Temperature
ENCLOSURE:	NEMA 4, 4x.
MOUNTING:	Wall
MANUFACTURER AND MODEL:	EE10 Series model EE10 FT6D04 or approved equal.

INSTRUMENT SPECIFICATION NUMBER:	I150
DEVICE:	Motion Detector
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Combination Infra-red and microwave
CALIBRATION:	User adjustable detection patterns
OUTPUT:	Form C Reed Relay rated 500 mA @ 300 VDC
POWER SUPPLY:	9 to 30 VDC
MOUNTING:	Surface Mount
MANUFACTURER AND MODEL:	C&K Systems DT-450C or approved equal

INSTRUMENT SPECIFICATION NUMBER:	I151
DEVICE:	Door Switch
TAG:	Refer to Instrument Index, Section 17700
TYPE:	Electronic
DISPLAY:	LED Status Indicator
OUTPUT:	SPDT Contact
ENCLOSURE:	Surface Mount

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I160
DEVICE:	Inline TSS Monitor/Transmitter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Sludge Supernatent
SENSOR MATERIAL:	Stainless Steel with wiper
SENSOR MOUNTING	Inline with proprietary Carbon Steel mounting kit. See drawing WB-A0410 for details
RANGE:	0-500 mg/L
INACCURACY:	Less than 5% of reading
REPEATABILITY	Less than 3% of reading
OUTPUT:	4 to 20 ma DC into 500 ohm load
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local indication of TSS
ELECTRONIC ENCLOSURE:	NEMA 4X. Remote wall-mount.
MANUFACTURER AND MODEL:	Hach Cerlic

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I162
DEVICE:	Inline Turbidimeter
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
MOUNTING:	Wall mount.
RANGE:	0.001 – 100 NTU
INACCURACY:	±2% of reading from 0 to 40 NTU; ±5% of reading from 40 to 100 NTU
REPEATABILITY	Less than 1% of reading
OUTPUT:	4 to 20 ma DC into 500 ohm load 2 Configurable alarm relays including a dedicated fault relay
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local indication of Turbidity
ELECTRONIC ENCLOSURE:	NEMA 4X.
MANUFACTURER AND MODEL:	Hach 1720E Turbidimeter and sc100 Controller Rosemount Endress & Hauser

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I165
DEVICE:	Flow Through pH/Temperature Analyzer
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
SENSOR MATERIAL:	Glass electrode
SENSOR MOUNTING	Wall mount
TEMPERATURE COMPENSATION:	Automatic, 0 to 100 Deg. C
RANGE:	0-14 pH
INACCURACY:	Less than ±0.5% of span
REPEATABILITY	Less than 0.01 pH
OUTPUT:	Two 4-20 mA DC outputs for process measurement and temperature 4 Configurable alarm relays including a dedicated fault relay
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local indication of pH and temperature
ENCLOSURE:	NEMA 4X transmitter housing. Wall-mount sensor and transmitter.
ACCESSORIES:	1 – Hand-held programmer
MANUFACTURER AND MODEL:	Rosemount 320B Sensor and 54e Analyzer Endress & Hauser ABB Foxboro

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I170
DEVICE:	Online Chlorine Residual Analyzer
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Refer to Instrument Index and P&ID Diagrams
MEASUREMENT METHOD:	Amperometric
MOUNTING:	Wall mount
RANGE:	0-5 mg/L
INACCURACY:	Less than ±1.0% of span
REPEATABILITY	Less than ±1.0% of span
OUTPUT:	4 to 20 mA DC into maximum 600 ohm load
	3 Configurable alarm relays including a dedicated fault relay
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local indication of Free/Total Chlorine
ENCLOSURE:	NEMA 4X transmitter housing. Wall-mount sensor and transmitter.
MANUFACTURER AND MODEL:	Wallace & Tiernan Micro/2000 Hach Rosemount Endress & Hauser

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I180
DEVICE:	Online Free/Total Chlorine and Ammonia Residual Analyzer
TAG:	Refer to Instrument Index, Section 17700
SERVICE:	Clearwell
MEASUREMENT METHOD:	UV Absorbance
MOUNTING:	Wall mount
RANGE:	0-5 mg/L Chlorine
INACCURACY:	Less than ±5.0% of span
OUTPUT:	Four 4-20 mA DC
	Dedicated fault relay
POWER SUPPLY:	120 VAC, 60 Hz
INDICATION:	Local LCD and keypad for indication of Free/Total Chlorine and Ammonia Residuals
ENCLOSURE:	NEMA 4
MANUFACTURER AND MODEL:	Chemscan UV-4100 Hach

END OF SECTION

INSTRUMENT LOOP DRAWINGS

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

1.2 Instrument Loop Drawings

.1 The following sixteen (16) Drawings show typical instrument loop wiring diagrams as referenced by this Specification Section. One (1) Drawing per loop will be completed by the Contractor and submitted for approval after award of Contract.

WB-A0451	Instrument Loop Diagram - Typical Motorized Valve - Open/Close
WB-A0452	Instrument Loop Diagram - Typical Motorized Valve - Modulating
WB-A0453	Instrument Loop Diagram - Typical Magnetic Flow Meter
WB-A0454	Instrument Loop Diagram - Typical Thermal Mass Flow Meter
WB-A0455	Instrument Loop Diagram – Typical Ultrasonic Level Transmitter
WB-A0456	Instrument Loop Diagram - Typical Thermal Dispersion Flow Meter
WB-A0457	Instrument Loop Diagram - Typical Chlorine Residual Analyzer
WB-A0458	Instrument Loop Diagram - Typical Conductivity Level Switch – Single Point
WB-A0459	Instrument Loop Diagram - Typical Turbidity Analyzer
WB-A0460	Instrument Loop Diagram - Typical pH Analyzer
WB-A0461	Instrument Loop Diagram - Typical MCC Starter
WB-A0462	Instrument Loop Diagram - Typical Turbidity/TSS Analyzer
WB-A0463	Instrument Loop Diagram - Typical Discrete Input
WB-A0464	Instrument Loop Diagram - Typical Valve Limit Switch Monitoring
WB-A0465	Instrument Loop Diagram - Typical Loop Powered Analog Input
WB-A0466	Instrument Loop Diagram - Typical 3-wire RTD

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

INSTRUMENT STANDARD DETAILS

1. GENERAL

1.1 References - General

.1 Refer to Section 17010 – Instrumentation and Control General Requirements.

1.2 Instrument Standard Details

.1 The following ten (10) Drawings provide standard instrumentation installation details as referenced by this Specification Section:

WB-A0401	Instrumentation Standard Details - Ultrasonic Level Transducer
WB-A0402	Instrumentation Standard Details - Loop Powered Remote Indicating Transmitter
WB-A0403	Instrumentation Standard Details – Hand Switch Mounting
WB-A0404	Instrumentation Standard Details – Pressure Gauge
WB-A0405	Instrumentation Standard Details – Pressure Switch
WB-A0406	Instrumentation Standard Details – Float Switch
WB-A0407	Instrumentation Standard Details – Thermowell Mounted RTD
WB-A0408	Instrumentation Standard Details – Pressure Transmitter and Inline Pressure Sensor
WB-A0409	Instrumentation Standard Details – Raw Water pH/ Turbidity Analyzer
WB-A0410	Instrumentation Standard Details – Turbidity/TSS Sensor

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

Vendor List for Instrumentation and Control Devices

Earth Tech Inc
850 Pembina Highway
Winnipeg
Manitoba
R3M 2M7
Tel: 204 477-5381
Fax: 204 284-2040

AMENDMENT RECORD

Issue	Date	Author	Checked	Approved	Amendment Details
A	7TH April 2005	N TOULSON			
B	May 11, 2005	S Tormey			Added Magnetic Level Indication. Added Magnetrol for Radar Level (Guided wave). Modified PLC's to Modicon Unity
C	Nov. 2, 2005	S Tormey			Added Krohne Magnetic Flow meters as per instructions from Vaughn Martin (City of Winnipeg)
D	Nov. 14, 2005	N TOULSON			Added Hach Water Hardness Monitor
E	Feb. 25 2006	N TOULSON			Added Differential Pressure Flowmeter, Compact Inline Flowmeter, Ammonia Analyser, Free Chlorine Analyzer, Total Chlorine Analyzer Added Chemtrac Particle Counter
F	March 14, 2006	S Tormey			Revised Column Titles
G	March 20, 2006	S Tormey			Replaced Fisher & Porter Flow meters w/ E&H

1 Introduction

The purpose of this document is to compile a list of acceptable manufacturers for the instrumentation and control equipment used as part of the City of Winnipeg's Water Treatment Program.

Description Of Equipment	**Acceptable Manufacturer** No.1	**Acceptable Manufacturer** No.2	**Acceptable Manufacturer** No.3	**Acceptable Manufacturer** No.4
Power Supplies, Conditioning, Suppression etc.				
DC Power supplies for instrumentation power	Wiedmuller	Sola Hevi Duty		
Transient Voltage Surge Suppression (TVSS)	Sola Hevi Duty STV100K	Leviton	Square D	Cutler Hammer
Power conditioning	Oneac			
UPS	Powerware	APC		
Flow Measuring and Monitoring				
Magnetic Flow Meters	Rosemount 8700	ABB Magmaster	Krohne	Endress and Hauser
Coreolis Flow meter				
Thermal Flowswitch	Ifm	Weber		
Thermal Mass Flowmeter	ABB	Brooks		
Variable Area Flowmeter	Omega	Kobold		
Differential Pressure Flowmeter	McCrometer			
Compact Inline Flowmeter	Weber			
Pressure Measurement and Monitoring				
Absolute Pressure Indicator Transmitter	Rosemount model 3051	ABB	Foxboro	
Differential Pressure Indicator Transmitter with integral manifold	Rosemount model 3051	ABB	Foxboro	

Description Of Equipment	**Acceptable Manufacturer** No.1	**Acceptable Manufacturer** No.2	**Acceptable Manufacturer** No.3	**Acceptable Manufacturer** No.4
Pressure Switches (electronic type)	Ifm	United Electric		
Pressure Switches (conventional type)	Ashcroft	United Electric	Barksdale	
Pressure Gauges	Ashcroft	H.O. Trerice	Budenberg	
3 Valve Manifolds	Anderson Greenwood			
Level Measurement and Monitoring				
Ultrasonic Level Indicator Transmitter	Siemens Multiranger 100/200	Magnetrol	Endress & Hauser	
Radar Type Level Indicator Transmitter	Endress & Hauser	Siemens	Magnetol	
Conductivity Level Switch	Endress & Hauser			
Vibration type level switch	Endress & Hauser			
Bypass Level Indicator	Krohne	Magnetrol		
Magnetic Level Indication	Magnetrol (Orion)	K-Tek KM26		
Float Switch	Flygt	Consolidated Electric	Warwick	Magnetrol
Sludge Blanket Level	Partech	Hach	Siemens	Cerlic
Capacitance Level Switch	Siemens	Endress & Hauser		
Admittance Level Switch	Magnetrol	Bestobell		
Temperature Measurement and Monitoring				
Temperature Transmitter (RTD)	Rosemount	ABB	Foxboro	
Temperature Switch	Ifm			

Description Of Equipment	**Acceptable Manufacturer** No.1	**Acceptable Manufacturer** No.2	**Acceptable Manufacturer** No.3	**Acceptable Manufacturer** No.4
Analytical Instrumentation				
Ph/ Temp	Rosemount	Endress & Hauser	ABB	Foxboro 870
Turbidity	Hach	Rosemount	Endress & Hauser	GLI
Free Chlorine Analyzer	Wallace & Tiernan	Hach	Rosemount	Endress & Hauser
Total Chlorine Analyzer	Wallace & Tiernan	Hach	Rosemount	Endress & Hauser
Ozone Analyzer	Crowcon			
Dew/Moisture Measurement	Veronics			
Particle Counter Analyzer	Hach	Chemtrac		
Suspended Solids Analyzer	Hach	Cerlic		
Ammonia Analyzer	Hach	Waltron	ATi	
Water Hardness Monitor	Hach			
Chloramination/Monochloramine Analyzer	Chemscan	Hach		
Valve Control				
Electric Actuators	Limitorque	Rotork		
Solenoid Valves	Asco Redhat			
I/P Converters	Omega	Moore		

Description Of Equipment	**Acceptable Manufacturer** No.1	**Acceptable Manufacturer** No.2	**Acceptable Manufacturer** No.3	**Acceptable Manufacturer** No.4
Relays, Barriers etc				
Plug in Relays	Omron	Idec	Potter& Brumfield	
Plug in Timers	Omron	Idec	Potter& Brumfield	
Analog I/S Barriers	MTL	Stahl	Peperl & Fuchs	
Digital Barriers	MTL	Stahl	Peperl & Fuchs	
I/S Relays	Gems	Warwick		
Signal Converters	Moore	Pheonix	Weidmuller	
Miscellaneous Items				
PLC'S	Modicon Unity			
Power Meters	PML			
Control Devices (pushbuttons, lamps etc.)	Allen Bradley 800 series	Cutler Hammer Type T		
Panel Instruments (analog indicators etc)	Crompton Instruments	Simpson	Newport	
Gas Detection Systems	Draeger	MSA	Crowcon	
Variable Frequency Drives				
LV Drives	ABB			
MV Drives	ABB			

Description Of Equipment	**Acceptable Manufacturer** No.1	**Acceptable Manufacturer** No.2	**Acceptable Manufacturer** No.3	**Acceptable Manufacturer** No.4