THE CITY OF WINNIPEG

BID OPPORTUNITY

BID OPPORTUNITY NO. 154-2005

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF DISSOLVED AIR FLOTATION AND FLOCCULATION EQUIPMENT

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PART B - BIDDING PROCEDURES

B1. PROJECT TITLE

B1.1 WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF DISSOLVED AIR FLOTATION AND FLOCCULATION EQUIPMENT

B2. SUBMISSION DEADLINE

B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, June 14, 2005.

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. ENQUIRIES

B3.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.

B3.2 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.

B3.3 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.

B3.4 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.

B3.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B3 unless that response or interpretation is provided by the Contract Administrator in writing.

B4. ADDENDA

B4.1 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.

B4.2 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.

B4.2.1 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.

B4.2.2 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.

B4.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 11 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

B5. SUBSTITUTES

B5.1 The Work is based on the materials, equipment, methods and products specified in the Bid Opportunity.

B5.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.

B5.3 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.

B5.4 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 material, equipment, method or product 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 Contract;

(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 Contract.

B5.5 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.

B5.6 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.

B5.6.1 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.

B5.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.

B5.8 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.

B5.9 No later claim by the Contractor for an addition to the price(s) because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

B6. BID SUBMISSION

B6.1 The Bid Submission consists of the following components:

(a) Form A: Bid;

(b) Form B: Prices;

(c) Form N: Salient Features,

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

B6.2 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.

B6.3 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.

B6.3.1 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.

B6.4 Bid Submissions submitted by facsimile transmission (fax) or internet electronic mail (e-mail) will not be accepted.

B6.5 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

B7. BID

B7.1 The Bidder shall complete Form A: Bid, making all required entries.

B7.2 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.

B7.2.1 If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B7.2.

B7.3 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.

B7.4 Paragraph 13 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.

B7.4.1 The name and official capacity of all individuals signing Form A: Bid shall be printed below such signatures.

B7.4.2 All signatures shall be original and shall be witnessed except where a corporate seal has been affixed.

B7.5 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.

B8. PRICES

B8.1 The Bidder shall state the lump sum price in Canadian funds for the Work on Form B: Prices.

B8.1.1 The price on Form B: Prices shall include:

(a) duty;

(b) freight and cartage, FOB Site;

(c) Provincial and Federal taxes [except the Goods and Services Tax (GST) and Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable] and all charges governmental or otherwise paid;

(d) profit and all compensation which shall be due to the Contractor for the Work and all risks and contingencies connected therewith.

B8.2 Payment of the lump sum price will be made to the Contractor in accordance with the payment schedule set out in D20.

B9. SALIENT FEATURES

B9.1 The Bidder shall complete Form N: Salient Features indicating the operating specification which the Bidder guarantees for each item or category of equipment identified thereon.

B9.1.1 When completing Form N – Salient Features, the Bidder shall use the following assumptions:

(a) That the raw water temperature is 5°C and has a dissolved oxygen concentration of 10mg/L.

(b) Recycle pumps and compressors will be installed generally as shown in the Bid Opportunity. For the purposes of calculating power consumption for the recycle pumps and compressors, assume that piping will be designed and sized as follows:

DAF Recycle Pump Suction Header [two (2) headers total from DAF Effluent to DAF Recycle Pumps].	Schedule 40 Carbon Steel, Epoxy Lined 550 mm nominal diameter
DAF Recycle Pump Suction Header (from the header to each pump).	Schedule 40 Carbon Steel, Epoxy Lined 400 mm nominal diameter
DAF Recycle Pump Discharge (from the pump to the saturator it serves).	316 Stainless Steel, 300 mm nominal diameter
DAF Saturator Discharge to DAF Basins.	316 Stainless Steel, 450 mm nominal diameter

DAF recycle header No. 1 (66% flow).	316 Stainless Steel, 250 mm nominal diameter
DAF recycle header No. 2 (33% flow).	316 Stainless Steel, 200 mm nominal diameter
Air compressor piping.	Sized for a maximum velocity of 15 m/s

(c) In order to determine recycle pump energy usage for Operating Conditions No. 1, No. 2 and No. 3 in Form N: Salient Features, the Bidder shall use the following calculation:

$$\text{Air Loading} = \frac{Q_r \times (C_{sat} - C_{atm})}{(1000 * Q_{ba\sin})} \quad \text{..... Equation (1)}$$

$$C_{sat} = \left(\frac{P_{sat}}{2.955}\right) \times 0.97^{T^{0.845}} \times 0.95 \times \frac{\eta_{sat}}{100} \quad \text{..... Equation (2)}$$

$$C_{atm} = \left(\frac{101.325}{2.955}\right) \times 0.97^{T^{0.845}} \quad \text{..... Equation (3)}$$

Where;

Q_r	= Recycle flow, in Litres/second
$Q_{ba\sin}$	= Flow through the DAF basin, not including the recycle flow, m^3/second
C_{sat}	= Concentration of dissolved air in recycle stream, mg air/L
C_{atm}	= Concentration of dissolved air in saturated water at atmospheric pressure, mg air/L
P_{sat}	= Saturator Pressure, kPa(absolute)
T	= Water Temperature, Celcius
η_{sat}	= Saturator Efficiency (in percent) For packed bed saturators, an efficiency of 95% shall be assumed For unpacked saturators, an efficiency of 65% shall be assumed, unless independently verified evidence is furnished in accordance with B5 to demonstrate that a higher efficiency is consistently achieved

B9.2 Further to B9.1.1(c) and notwithstanding clause 1.4 of Section 11490 of this Bid Opportunity, requests for approval to substitute unpacked saturators will be considered in accordance with B5.

B9.2.1 To be considered for approval, unpacked saturators must have a demonstrated efficiency of not less than 65%.

B9.2.2 Further to B9.1.1(c) and B15, if approval for the use of unpacked saturators is granted, the bid will be evaluated based on the saturator efficiency stipulated by the Contract Administrator in his response.

B9.3 The information submitted on by the Bidder on Form N – Salient Features will be considered a requirement of the Contract. The successful Bidder will be required to demonstrate this performance prior to Substantial Performance. Failure to demonstrate this performance will result in Liquidated Damages pursuant to D19.

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, or if the Bidder does not carry on business in Manitoba, in the jurisdiction where the Bidder does carry on business;

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

B10.2 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.

B10.2.1 Proof satisfactory to the Contract Administrator may include (but is not limited to):

(a) Evidence that the Bidder has supplied at least one previous installation using DAF as the main clarification process in a potable water treatment plant that:

(i) has a capacity of at least one hundred (100) megalitres per day (ML/d),

(ii) has been fully operational for at least two (2) years,

(iii) has been constructed within rectangular, concrete DAF basins, and,

(iv) uses a design Recycle Ratio of no greater than 15% when the plant is operating at full capacity

(b) Evidence that the product proposed for the mixers and/or flocculators specified in Section 11200 have been successfully supplied to not less than five (5) installations of a similar nature as this Bid Opportunity.

(c) Evidence that the product proposed for the float scraper design specified in Section 11490 has been successfully supplied to not less than four (4) installations of a similar nature as this Bid Opportunity and have been used in this capacity for at least five (5) years.

(d) If the float scraper proposed by the Bidder does not meet the requirements of B10.2.1(c), then the Bidder may demonstrate qualification with shop performance testing as specified in Clause 13.1.2.2 of Section 11490 of this Bid Opportunity.

B10.2.2 Evidence given by the Bidder to demonstrate qualification shall be in the form of references to similar work carried out by the Bidder and/or proposed subcontractor and shall include:

(a) Year of completion;

(b) Value of work

(c) Client

(d) Client contact, name and telephone number;

(e) Description of contract

B10.2.3 Determination of the satisfactory performance or success of the installation references shall be at the sole discretion of the Contract Administrator, based on the Contract Administrator's contact with the referenced installations.

B10.3 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 not be opened publicly.

B12.2 Within two (2) Business Days following the Submission Deadline, the names of the Bidders and their Total Bid Prices (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 12 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 for the time period specified in Paragraph 12 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.7.05(2), 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 13 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 13 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) Evaluated Bid Price, pursuant to B15.4; and

(d) economic analysis of any approved alternative pursuant to B5.

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), the evaluated Bid Price shall be the Total Bid Price adjusted for the comparison of Bids only, by adding construction costs and operating costs based on a fifteen (15) year life cycle cost evaluation.

B15.4.1 The Total Bid Price shall be the lump sum price shown on Form B: Prices. If there is any discrepancy between the lump sum price written in figures and the lump sum price written in words, the price written in words shall take precedence.

B15.4.2 The construction cost adjustment will be the costs for the facility required to accommodate the equipment using estimated construction costs for piling, concrete, site preparation, earthworks, building superstructure, and mechanical and electrical infrastructure.

B15.4.3 The operating cost adjustment will be the operating costs for the equipment based on:

(a) the Contract Administrator's estimate of building heating and ventilation energy costs based on the size of facility required to accommodate the equipment, plus

(b) the Contract Administrator's estimate of process electrical costs based on the information submitted by the Bidder in Form N – Salient Features.

B15.4.4 Energy costs used to establish the Evaluated Bid Price will be based on current utility rates applicable to services of a size and type expected for the completed Water Treatment Plant. The rates determined by the Contract Administrator will be used to establish the Evaluated Bid Price.

B15.4.5 For the purposes of the evaluated Bid Price, the Contract Administrator will assume that:

(a) The flocculator and scraper motors are the size specified on Form N – Salient Features and they operate at full speed at all times.

(b) The DAF system operates under the following conditions over the course of a year:

i) Operating Conditions No. 1 (November through February): is defined as the entire flocculation and DAF facility operating at a design flow of 100% of design capacity (409 ML/d), with all duty equipment in operation, and with the recycle system operating to produce an air loading of 10 g/m^3 treated water, at a saturator operating pressure of 590 kPa (g). The calculation of air loading will be as specified in B9.1.1(c).

(ii) Operating Conditions No. 2 (March through June) is defined as the entire flocculation and DAF facility operating at a design flow of 75%, with all duty equipment in operation, and with the recycle system operating to produce an air loading of 10 g/m^3 treated water, at a saturator operating pressure of 590 kPa (g). The calculation of air loading will be as specified in B9.1.1(c).

(iii) Operating Conditions No. 3 (July through October) is defined as the entire flocculation and DAF facility operating at a design flow of 50%, with all duty equipment in operation, and with the recycle system operating to produce an air loading of 10 g/m^3 treated water, at a saturator operating pressure of 590 kPa (g). The calculation of air loading will be as specified in B9.1.1(c).

B15.4.6 The adjustments to the Total Bid Price are for the purposes of evaluating and comparing Bids and will not affect the Contract Price. The Bidder is, however, advised to consider the provisions in D19.

B15.5 This Contract will be awarded as a whole.

B16. AWARD OF CONTRACT

B16.1 The City will give notice of the award of the Contract 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 the Supply and Delivery of Goods* (Form 21: 88 03) are applicable to the Work of the Contract.

C1.1.1 The *General Conditions for the Supply and Delivery of Goods* 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 the Supply and Delivery of Goods*, 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 “Board of Commissioners” or “Commissioner” wherever it appears in the General Conditions and substituting the “Chief Administrative Officer”.

D1.4 The General Conditions are amended by striking out “Tender Package” wherever it appears in the General Conditions and substituting “Bid Opportunity”.

D1.5 The General Conditions are amended by striking out “Tender Submission” wherever it appears in the General Conditions and substituting “Bid Submission”.

D1.6 The General Conditions are amended by striking out “Bidding Instructions” wherever it appears in the General Conditions and substituting “Bidding Procedures”.

D2. SCOPE OF WORK

D2.1 The Work to be done under the Contract shall consist of the Supply of Dissolved Air Flotation and Flocculation Equipment.

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

(a) Supply of dissolved air flotation and flocculation equipment, including (but not limited to) delivery to Site, training, performance verification support, operation and maintenance manuals, equipment, accessories, and spare parts.

(b) Electrical scope as defined in Section 16015.

(c) Control and instrumentation scope as defined in Section 17015.

D3. DEFINITIONS

D3.1 When used in this Bid Opportunity:

(a) **Business Day** means any Calendar Day, other than a Saturday, Sunday, Canadian or Manitoba Statutory Holiday or a City of Winnipeg 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) **Installation Contractor and/or Installer** means the General Contractor retained by the City, under a separate contract, to install the equipment supplied under this contract;

(d) **Substantial Performance** shall have the meaning attributed to it in the Builders’ Lien Act (Manitoba), or any successor legislation thereto.

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

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

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

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

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

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

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

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

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

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

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

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

(q) **Manufacturer** means the person, partnership or corporation responsible for the manufacture and fabrication of equipment provided to the City for the completion of the Work.

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

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

(t) **NEMA** means National Electrical Manufacturer's Association

(u) **Furnish** means supply

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

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

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

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

(z) **EEMAC** means Electrical and Electronic Manufacturer of Canada

(aa) **VFD** means Variable Frequency Drive

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

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

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

(ee) **Major Equipment** means all equipment for which shop drawing submittals are required as specified in Divisions 11, 16 and 17.

(ff) **Recycle Ratio** means the ratio of the design flow of water continuously recycled for the purpose of air delivery, to the design capacity of the plant

(gg) **Conventional DAF** means a DAF process which meets the requirements of Part E of this Bid Opportunity and which operates at a loading rate of no more than $18m^3$ of water per m^2 of basin area per hour ($m^3/m^2/hr$)

(hh) **High Rate DAF** means a DAF process which meets the requirements of Part E of this Bid Opportunity and which operates at a loading rate of no more than $36m^3/m^2/hr$.

(ii) **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.

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 specified from the Manufacturer and Manufacturer's Representative shall be provided and coordinated by the Contractor.

D3.4 Technical terms related to process pump operation shall be as defined in Section 11300.

D4. CONTRACT ADMINISTRATOR

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

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

Telephone No. (204) 284-0580
Facsimile No. (204) 453-5172

D5. NOTICES

D5.1 GC.7.05 is hereby amended to delete reference to "registered mail" and to replace same with "ordinary mail".

D5.2 GC.7.05 is further amended hereby to include delivery by facsimile transmission (fax) as an acceptable means of delivering notices, consents, approvals, statements, authorizations, documents or other communications required or permitted to be given under this Contract. Deliveries by fax will be deemed to have been received on the day of delivery, if a business day, or if not a business day, on the business day next following the day of delivery.

D5.3 Further to GC.7.05, all notices, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D5.4, D5.5 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.

D5.4 All notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at 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

D5.5 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

D6. INDEMNITY

D6.1 Notwithstanding GC.7.03, the Contractor shall save harmless and indemnify the City for twice the contract price plus two (2) million dollars against all costs, damages or expenses arising from actions, claims, demands and proceedings, by whomsoever brought, made or taken as a result of acts or omissions of the Contractor, his/her Subcontractors, employees or agents in the performance or purported performance of the Work, and more particularly from:

(a) accidental injury to or death of any person whether retained by or in the employ of the Contractor or not, arising directly or indirectly by reason of the performance of the Work, or by reason of any trespass on or damage to property;

(b) damage to any property owned in whole or in part by the City, or which the City by duty or custom is obliged, directly or indirectly, in any way or to any degree, to construct, repair or maintain;

(c) damage to, or trespass or encroachment upon, property owned by persons other than the City;

(d) failure to pay and obtain a discharge of a notice of claim for lien served upon the City in accordance with the requirements of The Builder's Liens Act;

(e) failure to pay a Workers Compensation assessment, or Federal or Provincial taxes;

(f) unauthorized use of any design, device, material or process covered by letters patent, copyright, trademark or trade name in connection with the Work;

(g) inaccuracies in any information provided to the City by the Contractor.

SUBMISSIONS

D7. AUTHORITY TO CARRY ON BUSINESS

D7.1 The Contractor shall 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, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

D8. WORKERS COMPENSATION

D8.1 The Contractor shall be registered with the Workers Compensation Board of Manitoba, shall provide and maintain Workers Compensation coverage throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

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.

(b) 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.3.01 for the return of the executed Contract.

D11. SUBCONTRACTOR LIST

D11.1 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.3.01 for the return of the executed Contract.

D12. WORK SCHEDULE

D12.1 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.

D12.2 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.

D12.3 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.

D12.4 Upon acceptance by the Contract Administrator, distribute copies of the revised schedule to Subcontractors and other concerned parties.

D12.5 The Contract Work Schedule shall be updated as the work requires and submitted to the Contract Administrator.

D12.6 The Contractor shall instruct recipients to report to the Contractor immediately any problems anticipated by the timetable shown in the Contract Work Schedule.

D12.7 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.

D12.8 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.

D12.9 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.

D12.10 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.

D13. SECURITY CLEARANCE

D13.1 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.

D13.2 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.

D13.3 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.

D13.4 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.

D13.5 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.

D14. INSTRUMENTATION AND CONTROLS

D14.1 Within ten (10) Business Days of the notification of the Award of Contract, the Contractor shall provide a list of products to be supplied under Division 17.

SCHEDULE OF WORK

D15. COMMENCEMENT

D15.1 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.

D15.2 The Contractor shall not commence any Work 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 D8;

(iii) evidence of the insurance specified in D9;

(iv) the performance security specified in D10;

(v) the subcontractor's list specified in D11;

(vi) the Contract Work Schedule specified in D12; and

(vii) the security clearance specified in D13.

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

D16. CRITICAL STAGES

D16.1 The Contractor shall achieve critical stages of the Work in accordance with the following requirements:

(a) Shop Drawings: Certified Shop Drawings for all Major Equipment shall be completed by August 31, 2005. Shop Drawing completion will be contingent upon all Shop Drawings having been reviewed by the Contract Administrator.

(b) Delivery:

(i) Delivery of all equipment to the site shall begin no earlier than June 1, 2006 and shall be completed no later than August 1, 2006,

(ii) The detailed delivery schedule will be based on the Installation Contractor and the City requirements and will be coordinated by the Contract Administrator, and included in the Contract Work Schedule. The equipment shall be supplied into the care of the Installation Contractor in accordance with this schedule,

(iii) Equipment delivery shall be considered complete upon the issuance of Form 100: Certificate of Equipment Delivery and Form 101: Certificate of Readiness to Install. A separate form shall be provided for each piece of Major Equipment. These forms are included in Section 01650 of this Bid Opportunity.

(c) Satisfactory installation: The Contractor shall provide support to the Installation Contractor as required to achieve satisfactory installation of all equipment supplied under this Contract by July 3, 2007.

(i) This support shall include (but is not limited to) providing a qualified representative on site as required to assist the Installation Contractor in achieving satisfactory installation of the equipment supplied under this Contract.

(ii) Satisfactory installation shall be considered complete upon the issuance of Form 102: Certificate of Satisfactory Installation. A single form is required for the entire system. This form is included in Section 01650 of this Bid Opportunity.

(d) Satisfactory performance and training: performance verification and training shall begin no earlier than July 3, 2007 and shall be completed on or before achieving Substantial Performance.

(i) The Contract Administrator will coordinate the performance verification and training for City personnel to coincide with the project commissioning schedule and will provide the Contractor a minimum of sixty (60) calendar days written notification of the acceptable date for the start of performance verification and training.

(ii) The Contractor shall provide draft copies of the operations and maintenance manual as specified in Section 01730, a minimum of thirty (30) Calendar Days prior to the start of training for City personnel.

(iii) During the performance verification and training period the Contractor shall provide qualified representation on site as required to assist the Installation Contractor in achieving and demonstrating satisfactory performance of the equipment supplied under this Contract.

(iv) Satisfactory performance and training shall be considered complete upon the issuance of Form 103: Certificate of Equipment Satisfactory Performance and Form T1: Certificate of Satisfactory Training. These forms are included in Section 01650.

D17. SUBSTANTIAL PERFORMANCE

D17.1 The Contractor shall achieve Substantial Performance by December 1, 2007.

D17.2 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.

D17.3 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.

D17.4 Substantial Performance cannot be achieved without completion of Forms 103, 104 and T1for all major pieces of equipment supplied under this contract.

D18. TOTAL PERFORMANCE

D18.1 The Contractor shall achieve Total Performance by December 31, 2007.

D18.2 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.

D18.3 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.

D19. LIQUIDATED DAMAGES

D19.1 If the Contractor fails to achieve critical stages, 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) Certified Shop Drawings in accordance with D16.1(a) – two thousand, six hundred dollars ($2,600.00);

(b) Delivery in accordance with D16.1(b) – two thousand, six hundred dollars ($2,600.00);

(c) Satisfactory installation in accordance with D16.1(c) - zero dollars ($0.00);

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

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

D19.2 If the Contractor fails to meet the performance guarantee from Form N: Salient Features when performance is verified in accordance with clause 13.2 of Section 11490 of this Bid Opportunity, the Contractor shall pay the City $1,300/kW (one thousand three hundred dollars per kW) of the aggregate total of the verified electrical consumption above the guaranteed performance.

D19.2.1 The aggregate total of the verified electrical consumption above the guaranteed performance will be calculated as follows:

$$C_{TOT} = (C_{A1} – C_{G1}) + (C_{A2} – C_{G2}) + (C_{A3} – C_{G3})$$

Where:

C_{TOT} = aggregate total of the verified electrical consumption above the guaranteed performance

C_{A1} = The sum of the actual power draw (kW) of all motors included in items 2.3 to 2.4 of Form N operating at Operating Condition #1 as verified per clause 13.2 of section 11490 of the Bid Opportunity.

C_{A2} = The sum of the actual power draw (kW) of all motors included in items 3.3 to 3.4 of Form N operating at Operating Condition #2 as verified per clause 13.2 of Section 11490 of the Bid Opportunity.

C_{A3} = The sum of the actual power draw (kW) of all motors included in items 4.3 to 4.4 of Form N operating at Operating Condition #3 as verified per clause 13.2 of Section 11490 of the Bid Opportunity.

C_{G1} = The sum of the guaranteed consumption (kWh/d) of all motors from items 2.3 to 2.4 of Form N, divided by 24.

C_{G2} = The sum of the guaranteed consumption (kWh/d) of all motors from items 3.3 to 3.4 of Form N, divided by 24.

C_{G3} = The sum of the guaranteed consumption (kWh/d) of all motors from items 4.3 to 4.4 of Form N, divided by 24.

D19.2.2 For the purposes of comparing verified electrical consumption to the performance guaranteed in Form N: Salient Features, the values submitted on Form N: Salient Features shall be assumed to occur at a constant rate.

D19.3 The amounts specified for liquidated damages in D19.1 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.

D19.4 The amount specified for liquidated damages in D19.2 is based on a genuine pre-estimate of the net present value of the City's extra operating costs over a fifteen year life cycle in the event that the Contractor fails to meet the performance guarantees of Form N: Salient Features.

D19.5 The City may reduce any payment to the Contractor by the amount of any liquidated damages assessed.

D19.6 The City will not pay a bonus for performance surpassing the guaranteed performance submitted on Form N: Salient Features or if the Contractor reaches critical stages earlier than those specified in D16.

MEASUREMENT AND PAYMENT

D20. PAYMENT SCHEDULE

D20.1 Further to GC.9.01 and GC.9.03, payment shall be in accordance with the following payment schedule:

(a) Measurement and payment for the Lump Sum Price as listed in Form B: Prices, shall include all shop drawings, equipment, accessories, spare parts, delivery, performance verification and training.

(i) One and one half (1.5) percent of the Lump Sum Price will be paid upon the delivery of Certified Shop Drawings for the entire scope of this supply Contract.

(ii) Eighty three and one half (83.5) percent of the Lump Sum Price will be paid upon issuance of Forms 100: Certificate of Equipment Delivery and 101: Certificate of

Readiness to Install and for transference of title to the City of Winnipeg for all Major Equipment.

(iii) A further five (5) percent of the Lump Sum Price will be paid upon issuance of Form 102: Certificate of Satisfactory Installation.

(iv) A further ten (10) percent of the Lump Sum Price will be paid upon the issuance of Form 103: Certificate of Satisfactory Performance and Form T1: Certificate of Satisfactory Training.

(b) Further to GC.9.03:

(i) Any payment made by the City to the Contractor on account of a progress estimate shall be less any holdback required to be made by The Builders' Liens Act, and such holdbacks or other amounts which the City is entitled to withhold pursuant to the Contract;

(ii) Payment on account of the final progress estimate, including the holdback made by the City pursuant to The Builders' Liens Act, shall be paid to the Contractor when the time for filing liens or trust claims has elapsed, unless the City is in receipt of a lien or trust claim.

WARRANTY

D21. WARRANTY

D21.1 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.

D21.2 Notwithstanding GC.10.01, GC.10.02 and D21.1, 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.

D21.3 The Warranty period for all goods specified in Section 11490 and Section 16815 shall be two years from Substantial Performance.

D21.4 Prior to Substantial Performance, the Contractor shall provide a written approval from the VFD and motor manufacturers certifying that both pieces of equipment are compatible when used together and maintain their individual warranties. One such written approval shall be provided for each different VFD and motor pair.

D21.5 New components which replace defective components under warranty shall have a warranty period identical to the warranty period that the replaced component had at Substantial Performance. The warranty period for the new components shall begin on the date that they are performance tested and accepted by the City.

CONTROL OF WORK

D22. PRIME CONTRACTOR – THE WORKPLACE SAFETY AND HEALTH ACT

D22.1 Further to GC6.26, 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).

D22.2 As Prime Contractor, UMA Projects (CM) Ltd. will administer a Project Safety and Health Management Plan. Compliance with this Plan will be mandatory for all personnel on the construction site and training and certification of all staff by the Prime Contractor's Safety Officer will be required.

D22.3 The Water Treatment Program Project Health and Safety Management Plan is available on the City of Winnipeg, Corporate Finance, Materials Management Branch internet site at http://www.winnipeg.ca/matmgt/projects

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. 154-2005

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF DISSOLVED AIR FLOTATION AND FLOCCULATION EQUIPMENT

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. 154-2005

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF DISSOLVED AIR FLOTATION AND FLOCCULATION EQUIPMENT

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 D11)

WINNIPEG WATER TREATMENT PROGRAM – SUPPLY OF DISSOLVED AIR FLOTATION AND FLOCCULATION EQUIPMENT

Name	Address

PART E - SPECIFICATIONS

GENERAL

E1. GENERAL

E1.1 These Specifications shall apply to the Work.

E1.2 The following are applicable to the Work:

Sections

Division 01 – General Requirements

Section	Description
01300	Submittals
01400	Quality Control
01650	Equipment Installation
01730	Operation and Maintenance Manuals

Division 11 – Process

Section	Description
11000	Equipment General Provisions
11060	Process Motors Less Than 150 kw
11200	Mixers and Flocculator, General
11210	Vertical Shaft Flocculators
11300	Process Pump General Requirements
11301	Horizontal End Suction Centrifugal Pumps
11301a	Detailed Pump Specification
11490	Dissolved Air Flotation Clarifier Equipment
11901	Factory Applied Maintenance and Corrosion Protection Coatings

Division 16 – Electrical

Section	Description
16010	Electrical General Requirements
16015	Scope of Supply
16122	Wires and Cables 0 – 1000 V
16131	Junction Boxes and Pull Boxes
16151	Wire and Box Connectors 0 – 1000 V
16811	Motor Starters to 600 V
16815	Variable Frequency Drives
16825	Control Devices

Division 17 – Instrumentation and Controls

Section	Description
17010	Instrumentation and Control General Requirements
17015	Scope of Supply
17110	Enclosures
17124	Instrumentation Cable
17130	Power Supplies
17140	Instrument Air Supply and Transmission
17211	Process Taps and Primary Elements
17212	Transmitters and Indicators
17213	Powered Actuators
17216	Switches and Relays
17271	Signal Conditioning Modules
17274	Panel Instruments
17275	Miscellaneous Panel Devices
17500	PLC and Operator Interface Requirements
17501	SCADA Interface Requirements

Drawings

Drawing No.	Description
WP-M001P	Conventional DAF – Lower Level Floor Plan – General Arrangement
WP-M001B	High Rate DAF – Lower Level Floor Plan – General Arrangement

E2. GOODS

E2.1 The Contractor shall supply Dissolved Flotation and Flocculation Equipment in accordance with the requirements hereinafter specified.

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, 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 submissions with a transmittal letter, in duplicate, containing:

.1 Date.

.2 Project title and number.

.3 Contractor's name and address

.4 Identification and quantity of each Shop Drawing product.

.5 Equipment tag number.

.6 Other pertinent data.

.3 Submissions shall include:

.1 Date and revision dates.

.2 Project title and number.

.3 Name 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 Supervisory Control and Data Acquisition (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 six (6) prints and one (1) reproducible copy of Shop Drawings. The Contract Administrator shall 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 Operation and Maintenance (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 six (6) copies of product data.

.3 Sheet size: 215 x 280 mm.

1.6 Electronic Submittals

.1 Provide electronic copies of all submittals within sixty (60) business days of stamped "Reviewed" or "Reviewed as Modified".

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**.

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 the latest edition published by the issuing authority, current at the date of tender closing.

.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 promptly [normally 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

EQUIPMENT INSTALLATION

1. INTENT

.1 This section describes general requirements for equipment relating to supply, installation, testing, operation, and performance verification.

2. EXPERTISE AND RESPONSIBILITY

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

.2 Should the Contract Administrator issue a 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 Installer shall be responsible for receiving, off-loading, and placing into storage all equipment at the site. **Form 100** shall be completed.

4. INSTALLATION ASSISTANCE

.1 Before commencing installation of equipment, the Installer 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 Installer is aware of all installation requirements, he shall so certify by completing **Form 101** 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 the 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 Installer shall contact the Manufacturer 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 Installer shall contact the Contractor who shall arrange for the Manufacturer's Representative to visit the site to provide assistance during installation, all at no cost to the City.

.3 Prior to completing installation, the Installer shall inform the Contractor who shall 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 Installer and the Manufacturer’s Representative shall 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**, 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 x 200 mm card stating “EQUIPMENT CHECKED. DO NOT RUN.” stencilled 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 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 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 Installer, Contractor, and the Contract Administrator.

.3 The Manufacturer's Representative shall conduct all necessary checks to equipment and if necessary, advise the Installer 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 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.

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

.7 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., shall be checked to ensure that they are within the specified or Manufacturer's recommended limits, whichever is more stringent.

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

.9 The equipment shall be restarted and run continuously for five (5) days. During this period, as practicable, conditions shall be simulated which represent maximum or most severe, average, and minimum or least severe conditions. These conditions shall be mutually agreed by the Manufacturer's Representative, the Contractor, and the 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.

.10 Performance tests shall be conducted either concurrent with or subsequent to the running test, as practicable and agreed between the Contract Administrator and the Contractor. Performance tests of equipment shall be carried out jointly with the City's Supervisory Control and Data Acquisition (SCADA) programming team. Instrumentation and Controls (I&C) connected to the marshalling panel shall include, but not to be limited to, simulation through SCADA. Performance tests shall also be attended by the City's operations staff as part of the acceptance procedure. Testing procedures and conditions shall be agreed to among the Contractor, Contract Administrator, and the City based on information in the Specification. The Contract Administrator is the final arbiter. However, the Contractor is solely responsible for conducting the tests.

.11 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.

.12 The Contractor shall submit the results of the performance tests to the Contract Administrator, documented and summarized in a format acceptable to the Contract Administrator. 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.

.13 All water, temporary power, heating, or any other ancillary services required to complete the initial demonstration, running test, and performance tests are the responsibility of the Installer. Chemicals are to be provided by the City.

.14 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. If the defects are attributed to the Contractor, additional costs incurred by the Installer, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.

.15 On successful completion of the demonstration, running test, and performance tests, **Form 103** attached to this Specification shall be signed by the Manufacturer's Representative, the Installer, and the Contract Administrator.

.16 When **Form 103** has been signed, the twenty-eight (28) day commissioning period shall commence. The equipment shall operate continuously over the twenty-eight (28) day period without experiencing a critical failure. A critical failure is defined as one that prevents the equipment from operating for an eight (8) hour period or that presents a safety hazard. For equipment that is designed not to operate on a daily basis, the commissioning period shall be defined as twenty-eight (28) consecutive days over which the piece of equipment is operated. Upon completion of the twenty-eight (28) day commissioning period, the equipment shall be deemed to have been handed-over and accepted by the Contract Administrator, unless the Contractor or Manufacturer’s Representative is notified otherwise.

7. OPERATOR TRAINING

.1 For equipment specified to include training, arrange for the attendance of the Manufacturer’s Representative to provide classroom training session(s) to operation and maintenance (O&M) staff.

.2 The training sessions shall last two (2) days each. The training sessions shall be given twice, to allow the City’s staff to attend either session. The training sessions shall be given during the three (3) week period preceding the start of the five (5) day operating period required for **Form 103**.

.3 Coordinate the training session(s) with the Contract Administrator.

.4 Prepare a draft handout taking the form of the relevant sections of the O&M Manual supplemented with any other information needed to fully explain the equipment operation.

.5 Prepare a draft agenda outlining the content of the training sessions. Allow half an hour at the beginning of the first period for the Contract Administrator to provide a summary of the design intent relating to that equipment. Following the engineering design overview, provide (as a minimum) information covering major equipment operation, mechanical and instrumentation engineering.

.6 Submit the draft handout and draft agenda to the Contract Administrator for review. Upon obtaining the Contract Administrator's acceptance, prepare ten (10) copies of the handout and submit to the Contract Administrator.

.7 Inform the Contract Administrator of any requirements for audio-visual aids five (5) days before the training session.

.8 The Manufacturers' Representative shall provide five (5) sets of training seminar manuals in similar format to the O&M Manuals prior to the training session. In addition, the Manufacturers' Representative shall be responsible to document each training session with a detailed set of minutes.

.9 Upon completion of training, the Contractor shall issue form T1: Certificate of Satisfactory Training, complete with all required signatures.

CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

We certify that the equipment listed below has been delivered into the care of the Installer. 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 Installer) Date

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

CERTIFICATE OF READINESS TO INSTALL
FORM 101

I have familiarized the Installer 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/Contractor.

_____ _____

(Authorized Signing Representative of the Installer) Date

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 Installer) Date

CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE
FORM 103

We certify that the equipment listed below has been continuously operated for at least five (5) 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 Installer) Date

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

1. Acknowledgement of Receipt of O&M Manuals.

_____ _____
(Authorized Signing Representative of the City) Date

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

_____ _____
(Authorized Signing Representative of the Installer) Date

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

.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

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 scheduled for completion in late 2007. 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. The purpose of this tender document is to select and pre-purchase the mechanical flocculators and the DAF equipment. The selected equipment will be used as the basis to finalize the design prior to construction with an Installer(s) selected through the public tendering process.

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 submitted 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 Society for Testing and Materials (ASTM).

.2 American National Standards Institute (ANSI).

.3 American Society of Mechanical Engineers (ASME).

.4 American Water Works Association (AWWA).

.5 American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE).

.6 American Welding Society (AWS).

.7 National Fire Protection Association (NFPA).

.8 Federal Specifications (FS).

.9 National Electrical Manufacturers Association (NEMA).

.10 Manufacturer's published recommendations and Specifications.

.11 General Industry Safety Orders (OSHA).

.12 Canadian Standards Association (CSA).

.13 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.

.5 Torsion and Vibration Analyses

.1 Provide torsional and lateral vibration analyses for the following equipment types:

.1 Engine drives except engine generators.

.2 Pumps, blowers, and compressors with constant speed drives of 500 horsepower and greater.

.3 Pumps, blowers, and compressors with variable speed drives (VSDs) of 100 horsepower and greater.

.4 Vertical pumps with universal joints and extended shafts.

.5 Other equipment as indicated.

.2 An experienced specialist from the equipment Manufacturer shall perform a complete torsional and lateral vibration analysis of each distinct equipment, motor, and VSD. These analyses shall identify the dry and wet lateral critical speeds plus the torsional critical speeds of the system. Appropriate lateral and critical speed maps shall be produced and submitted.

.3 No active critical speed shall be allowed within 25% of the operating speed range. No fabrication of the equipment shall be started until the analyses have been reviewed and accepted by the Contract Administrator.

1.5 Quality Assurance

.1 Costs: Pay all costs of inspection, start-up, 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 63 micro-inches shall be required for all surfaces in sliding contact.

.2 Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

.3 Rough finish not greater than 500 micro-inches 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 32 micro-inches.

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
Reciprocating Air Compressors		
multi-cylinder	2.0	Heavy Shock
single-cylinder	2.0	Heavy Shock
Pumps		
centrifugal or rotary	1.0	Uniform
progressing cavity	1.0	Uniform
Mixers		
Flocculator	1.25	Moderate Shock
Clarifiers	1.0	Uniform
Sludge Thickeners	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
Horizontal and end suction pumps	Gear or flexible spring
Vertical nonclog pumps with extended shaft	Flexible disc pack or Universal joint with carbon fiber composite shaft and steady bearing support(s)
Sludge collector	Gear coupling or jaw clutch
Single stage centrifugal blowers	Flexible disc pack
Air compressors	Gear or 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 Ensure adequate process stream protection 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) (whichever comes first)	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 Ensure adequate process stream protection from bearing lubricant leaks.

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 Packing around rotating shafts (other than valve stems) shall be "O"-rings, stuffing boxes, or mechanical seals, as recommended by the Manufacturer.

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 the 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 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 SERVICES OF MANUFACTURER

.1 Inspection, Start-up, and Field Adjustment: Where required by individual Sections, an authorized, experienced, and competent service representative of the Manufacturer shall visit the Site for the number of days indicated in the tender document to witness or perform the following and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

.1 Installation of equipment.

.2 Inspection, checking, and adjusting the equipment and approving its installation.

.3 Start-up and field testing for proper operation, efficiency, and capacity.

.4 Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements.

.2 Instruction of the City’s Personnel

.1 An authorized training representative of the Manufacturer shall be available on Site as specified within the tender document to instruct the City's personnel in the O&M of the equipment, including step-by-step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

.2 The representative shall have at least five (5) years experience in training. A resume of the representative shall be submitted.

.3 Training shall be scheduled four (4) weeks in advance of the session.

.4 Proposed training material and a detailed outline of each lesson shall be submitted for review. Review comments from the Contract Administrator shall be incorporated into the material.

.5 The training materials shall remain with the trainees after the session.

.3 Vibration Monitoring: Conduct equipment testing to ensure the operating equipment torsional and vibration measurements meet the acceptable limits. A written report documenting all the test results shall be submitted prior to issuing final payment. Any equipment not within the specified limits shall be repaired.

3.2 Field Tests

.1 Where indicated by the individual equipment Sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or no overheating of bearings or motor.

.2 The following field testing shall be conducted:

.1 Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable Standards.

.2 Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

.3 In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

1. GENERAL

1.1 Description

.1 Alternating current induction motors, 150 kW or less, National Electrical Manufacturers Association (NEMA) frame type.

.2 Unless specified otherwise, electric motors to be provided by the Manufacturer of the driven equipment, as an integral component of the driven equipment.

.3 Motors suitable for starting, accelerating, and running centrifugal pumps, fans, blowers, compressors, gears, progressive cavity pumps, or other loads fed via across the line starters, or variable frequency drive (VFD) as noted in the equipment data sheets.

1.2 Reference Standards

.1 Conform to the following reference standards:

.1 Canadian Standards Association (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 Efficient Test Methods for Three Phase Induction Motors.

.4 NEMA M1-7, Motors and Generators.

.5 NEMA M2.1, Standard for Lead Marking and Connections for Single Phase and Polyphase Induction Motors.

.6 Statutes of Canada, Energy Efficiency Act (most recent revision).

.7 Statutes of Canada, Energy Efficiency Regulations.

.8 Institute of Electrical and Electronic Engineers (IEEE) 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

.9 IEEE 114, Standard Test Procedures for Single-Phase Induction Motors.

.10 IEEE 841, Standard for Petroleum and Chemical Industry – Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors, Up to and including 500 horsepower (370 kW).

.11 NEMA MG1, Motors and Generators.

1.3 Submittals

.1 Shop Drawings: Submit with the related items of equipment in accordance with **Sections 11200, 11210, 11300, 11301, and 11490.** In addition, submit the following details: Provide the specified information for each typical size or type of motor driven equipment.

.1 Overall dimensions of motor.

.2 Shaft centreline to base dimension.

.3 Shaft extension diameter and keyway, coupling dimensions and details.

.4 Fixing support dimensions.

.5 Terminal box location and size of terminals.

.6 Arrangement and dimensions of accessories.

.7 Diagram of connections.

.8 Speed/torque characteristic.

.9 Weight of motor.

.10 Installation data.

.11 Rotation direction.

.12 Starting restrictions (time between starts).

.13 Terminal leads marking.

.14 Bearing data (including part numbers).

.15 Recommended lubricant.

.16 Design ambient temperature and temperature rise ratings.

.17 Torque characteristics including rated starting torque and breakdown torque.

.18 The American Bearing Manufacturers Association (ABMA) L-10 rated life for the motor bearings.

.19 The nominal efficiency for all motors.

.20 Class, zone, group and Underwriters Laboratories Inc. (UL) frame temperature limit code for explosion-proof motors.

1.4 Service Conditions

.1 Unless specified otherwise, provide motors suitable for continuous operation at an elevation of 300 m above sea level.

.2 Provide motors suitable for continuous operation in a 40°C ambient temperature.

1.5 Coordination

.1 For motors fed via VFD's, communicate motor requirements to and comply with drive requirements of the Manufacturer of the VFD.

.2 Motors powered via VFDs shall be rated for use with VFDs.

1.6 Quality Assurance

.1 Build motors in accordance with CSA C22.2 No. 100, CSA C22.2 No. 145, NEMA Standard MG1, IEEE 841 and to the requirements specified.

1.7 Shipment, Protection and Storage

.1 Ship, protect, and store equipment in a manner that prevents damage or premature aging.

.2 Handle motors with suitable lifting equipment.

.3 Store motors in heated, dry, weather-protected enclosure.

2. PRODUCTS

2.1 Approved Manufacturers

.1 GE.

.2 Westinghouse.

2.2 Materials

.1 Motors: to Electrical and Electronic Manufacturers of Canada (EEMAC) M1-7.

.2 Lead markings: to EEMAC M2-1.

.3 Unless specified otherwise, provide all motors with:

.1	Frame	Cast iron, steel, or cast aluminum.
.2	Endplates	Cast iron or cast aluminum.
.3	Terminal boxes	Cast iron, steel, or cast aluminum.

.4	Fan blades and shrouds	Non metallic, corrosion resistant.
.5	Hardware	Stainless steel.
.6	Windings	Copper, with non-hygroscopic insulation.

2.3 Motor Efficiency

.1 Use high efficiency motors with minimum guaranteed full-load efficiencies listed for NEMA Design E Table 12 – 11 for the size and type of motor provided.

.2 Use vertical motors with efficiency within 0.5% of minimum values stated for horizontal motors.

2.4 Horizontal and Vertical Motors, 0.25 to 150 kW

.1 General

.1 Unless otherwise specified, motors 0.25 to 150 kW to be three (3) phase, squirrel cage induction type, full voltage start, high efficiency, with copper windings.

.2 Service factor of 1.15 at 40°C ambient.

.3 Rated for 600/3/60 VAC service unless otherwise specified.

.4 Design motors for full voltage starting, capable of running successfully when terminal voltage is from +10% to –10% of nameplate voltage and terminal frequency is from + 5% to – 5% of nameplate frequency.

.5 Capacity sufficient to operate the driven load and associated devices under all conditions of operation without overloading.

.6 Design motor so that it is able to be re-started once after an immediate trip, after coasting to rest; and subsequently at sixty (60) minute intervals. This condition might apply whether the motor was run between starts or whether it was shut down immediately after start and not run between successive starts.

.2 Torque Requirements

.1 Provide motors capable of developing 150% of NEMA Design B locked rotor and pull-up torques with 100% of rated voltage applied and capable of developing in excess of NEMA locked rotor torque values at 90% of rated voltage.

.3 Inertia Loading

.1 Design motors to be capable of 200% of inertia loading values indicated in MG1-12.50, Table 12.3.

.4 Insulation

.1 Use Class F insulation

.2 Design motor for temperature rise less than 90°C at 1.15 service factor loading.

.3 Insulation to be non-hygroscopic.

.5 Varnish

.1 Dip and bake in Class H varnish a minimum of two (2) times. For 284T and larger frames, dip and bake a minimum of three (3) times.

.6 Current Imbalance

.1 Do not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

.1 Under 37.5 kW: 25%.

.2 37.5 kW and above: 10%.

.2 Base imbalance criteria upon the lowest value measured.

.7 Winding Over-Temperature Protection

.1 Provide stator winding over-temperature protection on all motors rated 45 kW and larger. Motors rated less than 45 kW to have stator winding over-temperature protection when required by the specific equipment Specification Section or if recommended by the driven equipment Manufacturer.

.2 Over-temperature protection for motors rated 45 kW and larger and other motors, where specified, to be NEMA MG1-12.53, Type 1, winding running and locked rotor over-temperature protection. One detector to be provided per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4 enclosure in Type two (2) motors and a NEMA 7C or 9 enclosure for Type three (3) motors.

.8 Bearings

.1 Select type of bearings on basis of torque and thrust requirements.

.2 Provide anti-friction bearings with grease lubrication, with one (1) year continuous operation without re-greasing.

.3 Provide sealed ball or cylindrical roller bearing type on motors less than 37.5 kW.

.4 Bearings on 37.5 kW motors or larger to be greasable ball bearing type, rated for a minimum L-10 life of 100,000 hours at the ambient temperature specified herein.

.5 Design bearings to have a maximum 45°C temperature rise at rated horsepower for four (4) pole and greater motors and 50°C for two (2) pole motors.

.6 Provide features to minimize the entrance of moisture and contaminants into the bearing chamber.

.9 Mounting

.1 End-bell mounted bearings: Provide motor sole plates, machined top and bottom, with a minimum thickness of 50 mm depending upon motor size.

.2 Pedestal type, independent of stator frame: Provide fabricated structural steel base, suitably braced to prevent distortion, to mount the stator frame and the bearing pedestals.

.3 Provide vertically mounted motors with drip shield.

.10 Direction of Rotation

.1 Design the motor so that it is capable of running in either direction of rotation by reconnecting the motor terminals.

.11 Frame

.1 Use a minimum of grade 25 cast iron, aluminum, or steel for frame, end brackets, fan cover, and conduit box. Refer to motor classifications.

.2 Provide two (2) bronze automatic breather drains at the lowest point in the motor frame.

.3 On frames sizes greater than 180, provide removable lifting eyes at the balance point of the motor, with a design safety factor greater than ten (10). Vertical motors require two (2) eyes, one (1) on each side of the frame.

.4 Use stainless steel hardware.

.12 Motor Classifications:

.1 Type 1 (General Duty): Unless specified otherwise, TEFC enclosures.

.2 Type 2 (Process): TEFC, suitable for moist and corrosive environment. All internal surfaces to be coated with an epoxy paint.

.3 Type 3 (Explosion-proof): Motors to be rated for operation in a Class 1, Zone 1, Group D hazardous location in accordance with CSA C22.1. Provide an approved breather/drain device to be provided in the motor drain hole.

.4 Type 4 (Exterior): TEFC or weather protected. All internal surfaces to be coated with an epoxy paint.

.13 Cooling Fans

.1 Fabricate external cooling fans of non sparking, corrosion resistant material.

.14 Terminal Box

.1 Incorporate an oversize terminal box with a volume greater than NEMA requirements, rotatable in 90° increments. Provide gaskets between the terminal box and frame and between the terminal box and cover.

.2 Provide diagonally split, gasketted, EEMAC 4 terminal boxes complete with threaded hub for conduit entry for open drip proof (ODP) and TEFC motors and adequately sized, diagonally split, gasketted EEMAC 7 terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.

.3 Provide a ground connection and lugs in the terminal box.

.4 Provide a separate terminal box for all motors required to have internal monitoring devices c/w terminal blocks.

.15 Vibration and Critical Speed

.1 Align and balance motors in the factory.

.2 Measure displacement horizontally and vertically in accordance with Canadian Electrical Manufactures Association (CEMA) Standard M1-20.58 and 20.59. Balance so that measured values are less than the following:

Nominal Running Speed (rpm)	Amplitude (mm)
3,600	0.0125
1,800	0.0175
1,200 and under	0.025

.3 Ensure that axial vibration, as measured at the bearing housings, does not exceed twice the above values.

.16 Motors are to be aligned and balanced with the related equipment in the Shop to minimize vibration and undue stresses. Maximum vibration of motor at the bearing housing is 12.5 microns peak to peak. As necessary, provide stainless steel balance washers.

.17 Sound pressure levels at 1.0 m, free field:

.1 93 kW (125 hp) and larger two (2) pole motors 90 dBA

.2 All other motors 85 dBA

.18 Where specified, equip motors with anti-condensation heaters suitable for connection to 120 volts, single phase, 60 Hz.

.19 Finishes

.1 Factory prime and paint in accordance with **Section 11901**.

.2 On interior of motor, apply rust inhibiting coating on all exposed machined surfaces.

2.5 Motors Smaller Than 0.25 kW

.1 General

.1 Unless otherwise specified, motors 0.25 kW and smaller to be squirrel cage, single phase, capacitor start, induction run type with copper windings.

.2 Construction features listed in this Section may be as normally supplied by the Manufacturer.

.3 Single phase motors to have Class F insulation.

.4 Small fan motors may be split-phase or shaded pole type.

.5 Provide copper windings.

.2 Rating

.1 Unless specified otherwise, motors to be rated for operation at 115/1/60 VAC, and continuous-time rated in conformance with NEMA Standard MG1, paragraph 10.35.

.3 Enclosures

.1 Unless otherwise specified, provide motors with TEFC or totally enclosed non-ventilated enclosures.

.2 Explosion-proof motors shall be approved by CSA for hazardous locations.

.3 Provide an over-temperature device in the enclosure to detect and automatically alarm to SCADA.

2.6 Motors for Variable Frequency Drives

.1 Select high efficiency units, inverter duty rated, CSA certified to be in conformance with NEMA MG1, Part 30 and Part 31.

.2 Design to ensure turndown of five (5): one (1) unless specified elsewhere.

.3 Use Type two (2) or Type three (3) motors.

.4 Insulation: Class F insulation, suitable for 90°C temperature rise, with a 1.0 safety factor, suitable for moist and corrosive environments and in accordance with NEMA MG1 Part 30 and Part 31. Provide additional treatment at winding end turns to minimize stray current failures.

.5 Design motors for variable frequency systems so that they are not required to deliver more than 80% of the motor's power rating by any load imposed by the driven machine at any specified operating condition or any condition imposed by the driven machine's performance curve at maximum operating speed.

.6 Ensure motors have adequate cooling capacity when operating through the entire speed range capacity of the drive.

.7 Enclosure and other insulation requirements are the same as required for constant speed motors.

2.7 Vertical Motors

.1 Unless otherwise specified, provide full voltage vertical motors with a Type P base specifically designed for vertical installation.

.2 Universal position motors are not acceptable.

.3 Provide vertical motors with solid shafts unless specified otherwise.

.4 Provide thrust bearing rating compatible with the loads imposed by the driven equipment.

2.8 Two Speed Motors

.1 Provide two (2) speed motors with separate windings. Single winding two (2) speed motors are not acceptable.

2.9 Power Factor Correction Capacitor Sizing

.1 The motor vendor to confirm the maximum capacitor size which may be connected to motors 7.5 kW and larger, on constant speed drives.

2.10 Motor Mounting

.1 Where equipment is specified to include C-Flange mounting, make motors compatible with this joining and alignment technique.

2.11 Finishes

.1 In accordance with **Section 11901.**

2.12 Equipment Identification

.1 Provide equipment identification in accordance with Division 11 and Division 16.

.2 Nameplates

.1 Provide motor nameplates on engraved or stamped stainless steel. Include information enumerated in NEMA Standard MG1, paragraph 10.37, 10.38 or 20.60, as applicable.

.2 Additionally, indicate:

.1 The ABMA L-10 rated life for the motor bearings for motors 37.5 kW and larger.

.2 The nominal efficiency for all motors.

.3 Class, Zone, group and UL frame temperature limit code for explosion-proof motors.

.4 Permanently fasten nameplates to the motor frame and position to be easily visible for inspection.

2.13 Spare Parts

.1 Provide maintenance materials and spare parts in accordance with **Section 11000**.

3. EXECUTION

3.1 Testing

.1 Perform tests and document results in accordance with Division 16.

.2 Test motor efficiency in accordance with CSA C390 and NEMA MG1, accounting for stray load losses, measured indirectly based on the IEEE method. Stamp efficiency on the motor nameplate.

END OF SECTION

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 Furnish submittals in accordance with **Section 01300 -** Submittals.

.2 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 pumps, 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 Drive and motor data in accordance with **Section 11060 –** Process Motors Less Than 150 KW.

.3 **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 all such certificates to the Contract Administrator.

.4 **Operation and Maintenance (O&M) Manuals:** Prior to start-up, furnish complete O&M manuals in accordance with **Section 01300**. 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 Manufacture's Service Representative

.1 **Erection and Start-up Assistance:** Service and instruction assistance by the Manufacturer's Representative shall be as per **Section 01650**, Subsection 5 – Installation Assistance, and Subsection 6 – Installation.

.2 **Instruction of City's Personnel:** Refer to **Section 01650**, Subsection 8 – Operator Training. 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 Guarantees & Warranties

.1 After Total Performance, the Contractor shall furnish to the City the Manufacturer's written guarantees, that the equipment will meet the published data and these Specifications. 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 316 except in septic environment.

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 **Pressure Gauges:** All pumps shall be equipped with pressure gauges installed at pump suction and discharge lines. Pressure gauges shall be located in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings. Pressure gauges shall be furnished in conformance with **Section 17212 -** Transmitters and Indicators**.**

.4 **Variable Speed Drives:** Variable speed drives, speed control equipment, and accessories shall be provided in accordance with **Section 16815 -** Variable Frequency Drives**.**

.5 **Motors:** Motors shall be heavy duty and shall comply with **Section 11060 –** Process Motors Less Than 150 KW**.**

.6 **Flanges:** Equipment flanges shall conform to ANSI B16.1 or B16.5 dimensions.

.7 **Lubrication:** Equipment shafts, bearings, gears, and other moving parts shall be grease, oil, or Product lubricated. All lubricating points shall be filled with the recommended lubricants.

.8 **Equipment Seals:** Seals on equipment shafts shall be the Manufacturer's suggested best quality mechanical seals or stuffing boxes, as best suited for each individual application. Where necessary, such seals shall be oil lubricated or water-flushed.

2.4 Tools and Spare Parts

.1 **Tools:** Special tools necessary for maintenance and repair of the equipment and one pressure grease gun for each type of grease required for pumps, mixers, 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:** Supply 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 One (1) set of printed circuit control boards, if applicable.

3. EXECUTION

3.1 Acceptance

.1 In the event of failure of any equipment to meet any of the above requirements or efficiencies, the Contractor shall make all necessary modifications, repairs, or replacements to conform to the requirements of the Contract Documents and the equipment shall be re-tested until found satisfactory.

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, commissioning, and training for vertical-shaft flocculating assemblies and appurtenant equipment, 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 Guarantees and Warranties

.1 After Total Performance, the Contractor shall furnish to the City the Manufacturer's written guarantees, that the equipment will meet the published data and these Specifications. 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.

.2 To ensure design integration and system responsibility, the flocculator gear reducer must be designed and manufactured by the flocculator supplier. 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 11060 –** Process Motors less than 150 kW. All

motors shall be 600 V, three (3)-phase. The motor shall be started with a variable frequency drive (VFD) in accordance with **Section 16811 –** Motor Starters to 600 V 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, with all travel expenses covered by the Contractor. 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.

2.2 FLOCCULATOR UNITS

.1 **General:** Each flocculator unit shall consist of a gear reducer with electric motor, flexible motor coupling, gear reducer pedestal, mounting plate, gear reducer output shaft coupling, vertical mixing shaft, and mixing impeller. No underwater bearings will be permitted.

.1 The units shall be designed to transmit to the water the indicated velocity gradient "G" based on the minimum water temperature indicated below, to provide an adequate pumping capacity, and to produce eddies which are essential to the flocculation process, at a minimum shear.

.2 **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.

.3 **Criteria:** The flocculators shall meet the following design criteria:

Parameter	Design Criteria
Maximum Process Design Flow	409 ML/d
Minimum Process Design Flow	100 ML/d
Number of Flocculation Trains	2
Number of Flocculation Basins per Train*	4 (total-directly coupled to DAF)
Nominal Flocculation Time	16 min
Number of Cells in Series	Three (3) per basin Divided by perforated baffle walls
Basin Dimensions*	8 m Wide x 5.15 m Long 4.7 m Deep (Wetted), 5.5 m Deep Total
Mixing System	Mechanical, vertical
Flocculation impeller	Hydrofoil
Direction of Flow	Upflow
Design G-value (all stages):	Maximum 100 s^{-1}, variable speed
Number of flocculators	6 per basin, 2 per cell
Minimum water temperature	0.5 ^{o}C
Ratio of Impeller Diameter to Tank Diameter (min)	0.35
Maximum Impeller Distance off Bottom of Tank	1.25 metres
Maximum Tip Speed	2.1 m/s
Minimum Motor Size per Unit	2 kW

Note: * To be finalized after DAF system selection.

.4 **Drive:** Flocculators shall be driven by a heavy-duty, high-efficiency, TEFC electric motor coupled to the gear reducer by means of a flexible coupling, and suitable for operation on a 600 V three (3)-phase power supply. The flocculator will be equipped with a new, infinitely variable speed control unit (VFD), meeting the requirements of **Section 16815 –** Variable Frequency Drives. The VFD shall have a minimum turndown ratio of four (4) to one (1). The flocculator motors shall be rated for inverter duty, in accordance with NEMA MG1, part thirty (30) and thirty-one (31), with a separate stainless steel nameplate affixed to the motor.

Each drive assembly shall be of ample capacity to supply the required power and torque output at all speed settings within the speed range. Motor and gear reducer shall be equipped with lifting lugs.

.5 **Gear Reducer:** Only gear reducers designed and manufactured by the flocculator supplier shall be acceptable. Each gear reducer shall be of the horizontal right-angle or vertical offset

shaft arrangement type, ruggedly encased in a cast iron or fabricated steel heavy duty housing designed for the conditions it will encounter. Gears shall be helical or spiral bevel type or a combination of both. Worm gear arrangements will not be acceptable. Motor mounted pinions are not acceptable. The reducer shall be designed and manufactured in accordance with the AGMA Standard and shall have a service factor of 1.5 based upon the full motor nameplate horsepower at maximum operating speed. Bearings shall be greased - or oil-lubricated with a minimum L-10 life of 100,000 hours, sufficiently sized to stabilize the impeller assembly under all operating conditions. Gear reducer output shall be equal or greater in diameter than the mixing shaft.

.6 **Setting:** Each drive assembly shall be furnished as a unit, with a pedestal type mounting base with square footplate for mounting to the supporting structure. The pedestal type mounting base shall be provided by the Manufacturer and shall facilitate oil changes and elevate the gear reducer output shaft coupling above the mounting surface. Lifting lugs shall be provided on the motor and gear reducer. The unit shall be self-supporting. No auxiliary motor supports shall be required.

.7 **Lubrication:** Lubrication of each speed reducer shall be by means of an efficient oil splash mechanism. The drive shall be provided with a dip stick to observe oil level. Each drive must have an effective drywell feature to eliminate oil leakage down the output shaft. Output shaft bearings may be grease lubricated, including a high quality lip seal to retain grease. All oil fill and drain lines and grease fittings shall be in easily accessible locations, at a minimum of 250 mm above the mixer mounting surface. All lubricated items must be located in leak proof enclosures.

.8 **Impeller and Shaft:** Mounted at the end of each flocculator shaft shall be a stainless steel impeller bolted to a cast or fabricated hub. All submerged nuts, bolts, and washers shall be Type 316 stainless steel. The hub shall be of sufficiently large diameter, and impellers shall be designed to assure maximum efficiency by preventing central backflow. The impeller assembly shall be securely keyed to the shaft. Shaft stresses shall be limited to 62,000 kPa and impeller stresses to 82,000 kPa.

.9 **Impeller Adjustment:** The impeller shaft shall be of Type 316 stainless steel. The impeller shall be connected to the shaft with a hook key for security. An extended keyway shall be provided to allow for vertical adjustment of each impeller in 75 mm increments plus or minus 300 mm from its recommended position.

.10 **Shaft Coupling:** The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged coupling, of either the welded or interference fit hub type. Mating coupling faces shall have a rabbeted male and female pivoted connection for accurate concentricity, and shall not require match marks for alignment. The coupling shall be designed to minimize shaft run-out, and it shall be located near the tank deck level.

.11 **Structural Strength and Stability:** Structural members and connections shall be designed to withstand, within normal working stresses and deflections, all loads imposed on them by rotation of the assembly at maximum design speeds submerged and dry, as well as loads which may be superimposed during or subsequent to erection while the basins are empty.

The shaft shall be designed for a maximum stress not to exceed 75,000 kPa while under maximum operating loads. The shaft shall be of the overhung design and the use of bottom steady bearings shall not be permitted. The shaft impeller design shall be such that the operating speed shall not exceed 70% of the first lateral critical speed. Lower shaft straightness, rigid coupling squareness, and output shaft accuracy shall give a maximum runout at the lower end of the shaft of 3 mm ($^1/_8$ inch) for every 3.05 m (10 feet) of overhang, as measured when turning over by hand.

.12 **Materials**

.1 Flocculator shaft, impeller, and any submerged supports shall be 316L stainless steel to ASTM A941. No painting or coatings are necessary on stainless steel surfaces.

.2 The base plate, support frame, motor, and other ancillary items shall be ductile iron to ASTM A897 or cast iron to ASTM A48. The ductile iron or cast iron surfaces shall be epoxy coated in accordance with AWWA C210 with the coating meeting the requirement of NSF 61. Equivalent coatings will be considered.

2.3 APPROVED MANUFACTURERS

.1 General

.1 Chemineer, Inc.

.2 Lightnin.

.3 Philadelphia Mixing Solutions.

.4 Hayward Gordon.

.2 All flocculators shall be manufactured by the same company.

2.4 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 [four (4) sets total]:

.1 One (1) impeller.

.2 One (1) gearbox.

.3 One (1) set of printed circuit control boards, if applicable.

3. EXECUTION

3.1 INSTALLATION

.1 Provide installation verification, testing, and commissioning assistance and training as specified herein.

END OF SECTION

PROCESS PUMP GENERAL REQUIREMENTS

1. GENERAL

1.1 Description

.1 This Section defines the general requirements for the supply of all pumps required for this project.

1.2 Definitions

.1 The terms in the Specification generally comply with the definitions of the Hydraulic Institute.

.2 Definitions:

.1 Efficiency: Pump efficiency shall be calculated as the delivered hydraulic power divided by the electrical power at the inlet box of the pump. It shall take full account of mechanical and electrical losses.

.2 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.

.3 Best Efficiency Point (BEP): The BEP is the point in the pump performance curve where the pump operates at its highest efficiency.

.4 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.

.5 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.

.6 Low Speed Point: The minimum flow and head conditions against which a variable speed pump is expected to operate.

.7 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 defined by the pump supplier 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

.1 Prior to delivery, ensure that the Certificate of Readiness (Form 101) is completed to ensure that the Installer is ready to receive the specified equipment.

.2 Ship pre-assembled to the degree that is possible. Inform Installer 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, instruct Installer of specific requirements to 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 as defined for the low head point.

.5 Supply pumps capable of operating at 30% of the flow at the rated capacity with good efficiency 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 centrifugal pumps handling clean water, supply gauges for the inlet and outlet of each pump.

.3 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.

.4 For centrifugal pumps handling effluent water, supply one (1) pressure sensor and one (1) gauge for each pump. Mount on valved pipe that extends from inlet to outlet of pump, with a connection for flushing water.

.5 Gauges

.1 Supply gauges that are 60 mm diameter, 6.35 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 Approved Manufacturers: Ashcroft, H.O. Trerice.

.6 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 317L Stainless Steel	316 or Hastelloy C	Buna-N or Viton	Silicon Carbide on Carbon

.6 Provide connections for cooling/flushing water.

.7 Approved Manufacturers are:

.1 Durametalic.

.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 Finishes

.1 Factory prime all pumps in accordance with **Section 11901 –** Factory Applied Maintenance and Corrosion Protection Coatings.

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 Field test all pumps greater than or equal to 3.7 kW, and smaller units where noted, to verify performance.

.2 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.

.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 will be performed at no extra cost to the City.

END OF SECTION

HORIZONTAL END SUCTION CENTRIFUGAL PUMPS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply, verification of the on-site equipment installation, testing, commissioning, and training of horizontal, end suction centrifugal dissolved air flotation (DAF) recycle pumps as part of the DAF clarifier equipment package.

2. PRODUCTS

2.1 Detailed Pump Specification Sheets

.1 Specific pumps are listed in detailed Specification sheet – **Section 11301a –** Detailed Pump Specification. Required performance data are presented.

2.2 Approved Manufacturers

.1 Aurora Pump.

.2 Peerless.

.3 Cornell.

.4 Ingersol-Dresser.

.5 PACO.

2.3 Impellers

.1 Provide multi vane, enclosed, one (1) piece single suction impellers.

.2 Fabricate impellers of American Society for Testing and Materials (ASTM) B584 bronze or equivalent.

2.4 Casings

.1 Fabricate casing of one piece ASTM A48 cast iron or equivalent.

.2 Provide a flanged end suction inlet and a flanged vertical centreline discharge outlet.

.3 Pressure test casings at 1.5 times the pressure developed by the pump at shut off head.

.4 Provide tapped and plugged holes for priming and draining.

.5 Make the casing bore large enough to permit back pullout of the impeller without disturbing the casing or suction and discharge piping.

2.5 Shafts

.1 Fabricate pump shafts of American Iron Steel Institute (AISI) C1045 carbon steel or equivalent

.2 For shaft sleeve, use series 400 stainless steel.

.3 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 $L^3/D^4<80$.

.4 Key the impeller to the shaft, and secure by an impeller bolt. Design the assembly to prohibit loosening of the connection due to torque developed during operation. Design the assembly to allow a smooth flow path without causing the accumulation of stringy material.

.5 Provide a renewable shaft sleeve to protect the shaft through the sealing box area.

2.6 Wearing Rings

.1 Fit the casing with a bronze wear ring to minimize abrasive and corrosive wear. Provide a radial type wear ring, press fitted into the casing.

2.7 Flexible Coupling

.1 Connect the pump shaft and the motor shaft with a flexible coupling. Refer to **Section 11300 –** Process Pump General Requirements.

2.8 Motors

.1 Motor types, voltages, service conditions, and power ratings are indicated in the detailed pump Specification sheets.

.2 Comply with the provisions of **Section 11060** – Process Motors under 150 kW.

2.9 Bases

.1 Manufacture pump bases of cast iron or fabricated steel.

.2 Provide grouting holes, a minimum of one (1) at the centre and one (1) at each corner, of sufficient size to allow for the pouring of grout into the annular space.

.3 Bases are to have square corners in all three (3) directions, with parallel surfaces.

3. EXECUTION

3.1 Manufacturer's Representative

.1 A Manufacturer's Representative is to attend the Site prior to the arrival of the equipment to train the Installer and ensure a seamless custody transfer.

.2 A Manufacturer's Representative shall attend the Site to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation Training

.1 Instruct the Installer in the methods and precautions to be followed in the installation of the pump(s).

.2 The Manufacturer's Representative shall verify the Installer's understanding by completing **Form 101** as shown in **Section 01650 –** Equipment Installation.

3.3 Testing

.1 Ensure that each pump, including all component parts, operates as intended.

.2 Cooperate with the Installer to fulfill the requirements for successful testing of the equipment, as documented by **Form 103**, illustrated in **Section 01650 –** Equipment Installation.

.3 Refer to **Section 11300** – Process Pump General Requirements for testing requirements.

3.4 Commissioning

.1 Attend during commissioning of the process system which includes the pumps specified in this Section to ensure that each pump functions as intended in the process system.

END OF SECTION

DETAILED PUMP SPECIFICATION

1. GENERAL DESCRIPTION

1.1 Identification:

.1 Pump Name - Dissolved Air Flotation (DAF) recycle pumps.

.2 Equipment Number - To be determined.

.3 Quantity - Six (6).

.4 Location - Flocculation and DAF complex.

1.2 Operating Conditions: The Work of this Section shall be suitable for long-term operation under the following conditions:

.1 Duty – Continuous.

.2 Drive - Variable speed.

.3 Ambient environment – Indoors.

.4 Ambient temperature, (°C) - Ten (10) to twenty five (25).

.5 Ambient relative humidity (%) - 20 to 100.

.6 Fluid service - Clarified DAF subnatant.

.7 Fluid temperature, (°C) - One (1) to twenty (20).

.8 Fluid pH range - 5.0 to 8.5.

.9 Fluid specific gravity - 1.0.

.10 Fluid viscosity (Centipoises @ 20 °C) - 1.12.

.11 Minimum available net positive suction head (NPSH) (m) – 15.

1.3 Performance Requirements:

.1 Note: Manufacturer shall confirm all performance requirements to be compatible with the requirements of the DAF system, see **Section 11490 –** Dissolved Air Flotation Clarifier Equipment. The performance requirements listed herein are to be considered approximate. It is the responsibility of the Contractor to ensure selection of a pump compatible with the requirements of the DAF system, see **Section 11490 -** Dissolved Air Flotation Clarifier Equipment.

.2 Maximum shutoff head (m) – 80.

.3 Design flow capacity (L/s) – 121.

.4 Design flow pump head [total dynamic head (TDH) m] – 65.

.5 Design flow minimum pump efficiency (%) – 75.

.6 Maximum flow capacity at maximum speed (L/s) – 150.

.7 Maximum flow pump head (TDH m) plus and minus 1 m – 55.

.8 Maximum flow minimum pump efficiency (%) – 70.

.9 Maximum flow NPSH required (m) – 12.

.10 Minimum flow capacity at maximum speed (L/s) – 100.

.11 Minimum flow pump head (TDH) at maximum speed (m) plus and minus 1 m – 80.

.12 Minimum flow pump efficiency (%) – 70.

.13 Maximum pump speed (rpm) - 1,150.

.14 Maximum motor speed (rpm) - 1,200.

.15 Minimum motor size (kW) – 100.

1.4 Pump Dimensions:

.1 Impeller diameter, min (mm) - 8.5.

.2 Suction flange, min size (mm) – 400.

.3 Discharge flange, min size (mm) – 300.

.4 Suction flange rating, American National Standards Institute (ANSI) (psi) – 125.

.5 Discharge flange rating, ANSI (psi) – 125.

2. PUMP REQUIREMENTS

2.1 Construction: Construction of horizontal close-coupled end-suction pumps shall conform to the following requirements:

.1 Casing - Cast iron American Society for Testing and Materials (ASTM) A 48.

.2 Pump base - Cast iron or steel base plate with drain rim or pan.

.3 Impeller - Bronze ASTM B 584 statically and dynamically balanced, enclosed.

.4 Case wear ring - Bronze ASTM B 62, B 271, or B584.

.5 Shaft - Steel AISI C1045 or SAE 1112 or 4140, designed for max 0.002-inch deflection at sealing face at max load.

.6 Shaft sleeve - Bronze ASTM B 62, B271, or B584.

.7 Seal - Mechanical seal.

.8 Mounting - Close-coupled.

.9 Bearings - Ball bearings as specified in **Section 11060** - Process Motors under 150 kW.

.10 Lubrication – Grease.

2.2 Drive**:** Direct drive with heavy duty, horizontal, electric motor suitable for 600 volt, three (3) phase, 60-Hz power supply, in accordance with Section 11060 – Process Motors under 150 kW.

3. PUMP CONTROLS

.1 Pumps shall be controlled in accordance with the Specifications of Division 17, Instrumentation & Controls (I&C).

4. SPARE PARTS: The following spare parts shall be furnished for each pump:

.1 One (1) mechanical seal.

.2 One (1) casing wearing.

.3 Two (2) sets of all gaskets, seals, and O-rings.

5. APPROVED MANUFACTURERS

.1 Aurora Pump.

.2 Peerless.

.3 Cornell.

.4 Ingersoll-Dresser.

.5 PACL.

END OF SECTION

1. SCOPE

1.1 Scope

.1 This Section covers the supply, verification of the on-site equipment installation, testing, commissioning, and training of dissolved air flotation (DAF) clarifier equipment in the flocculation/DAF complex. For the purposes of this Specification, two distinct types of DAF process are defined. "Conventional DAF" is deemed as a DAF process which meets the requirements of this Specification, and which operates at a loading rate of no more than 18 m^3 of water per m^2 of basin area per hour ($m^3/m^3/hr$). "High-Rate DAF" is deemed as a DAF process which meets the requirements of this Specification, and which operates at a loading rate of no more than 36 $m^3/m^3/hr$. Preliminary design Drawings for both the conventional and high-rate DAF alternatives are included for reference.

.2 Overall design criteria for the DAF basins are as follows:

Parameter	Design Criteria
Maximum Process Design Flow	409 ML/d
Minimum Process Design Flow	100 ML/d*
Hydraulic Capacity	613.5 ML/d**
Number of DAF Trains	2
Number of DAF Basins per Train*	4 (8 total-directly coupled to Flocculation Basins)
Nominal Surface Loading Rate:	Conventional DAF: No greater than 18 m/hr High-Rate DAF: No greater than 36 m/hr
Basin Dimensions:	**Conventional DAF:** 11 m long 11 m wide, ≥ 2.5 m water depth **High-Rate DAF:** 10 m wide 6.04 m long 5.5 m water depth (including depth below false floor)

Note: * This minimum design flow would be treated with one of the two (2) trains off-line.

** Hydraulic capacity is defined as the capacity that can be passed through the basins without causing overflow. The DAF Equipment Manufacturer is not responsible for guaranteeing water quality performance at flows greater than the Maximum Process Design Flow.

.3 DAF clarifier equipment shall be supplied as follows:

	No. Units per DAF Basin	No. of Units per Train*	Total No. Units
DAF Float Reciprocating Scrapers.	1	4	8
Float Beaches.	1	4	8
Saturator Vessels.	1 per 2 basins	2	4
Recycle Injection Headers.	2	8	16
DAF Compressor Packages.	--	--	2
Float Trough Spray Wash Headers.	1	4	8
DAF Basin Headwall Spray Wash Headers.	1	8	8
DAF Basin Sidewall Spray Wash Headers.	2	8	16
Recycle Pumps.	--	2 duty, 1 standby	6
Saturator Pressure Retention Valves.	--	2	4
DAF Control Panels.	1 per train	1	2

Note: *One train is equivalent to four DAF basins.

.4 Provide Shop Drawing in compliance with **Section 01300 -** Submittals**.**

.5 Provide Operations and Maintenance (O&M) Manuals in accordance with **Section 01730 -** Operation & Maintenance Manuals**.**

.6 Principal items included hereunder to be supplied by the Contractor and installed by the Installer shall include the following:

.1 Float scrapers.

.2 Float beaches.

.3 Saturator vessels.

.4 Recycle injection headers.

.5 DAF compressor packages, including oil removal filters, and compressed air piping between the DAF compressor packages and the saturator vessels.

.6 Spray wash headers mounted along the headwall of the basin, along both sidewalls, and above the float trough.

.7 DAF Recycle pumps.

.8 Saturator pressure retention valves.

.9 Effluent laterals (conventional DAF only) or perforated false floor (high-rate DAF only).

.10 DAF main control panels and local control panels including electrical components and devices and panel power and control wiring.

.11 Variable Frequency Drives (VFD's) and digital soft starters as specified within Section 16811 – Motor Starters to 600 Volts.

.12 DAF system field mounted instrumentation and panel mounted instrumentation.

.7 The following items of equipment and related Work are not part of the Contractor's scope of supply but shall be available for connection to the DAF system for a complete and functional installation.

.1 DAF effluent weir.

.2 Recycle suction piping and valves between DAF effluent channel and DAF recycle pump suction.

.3 Recycle discharge piping and valves between DAF recycle pump discharge and saturator vessels.

.4 Recycle piping and valves (excluding saturator pressure retention valves) between saturator vessel discharge and the limits of the recycle injection headers.

.5 Recycle injection piping flow meters and transmitters.

.6 Air supply for the pneumatic actuators on the saturator pressure retention valves, if required.

.7 Power and control wiring, instrumentation, and alarm signal wiring between the plant power and Supervisory Control and Data Acquisition (SCADA) system and the DAF main control panel.

1.2 Reciprocating Float Scrapers

.1 Each float scraper shall be supplied complete with all mechanical equipment required for operation, including electric drive motor, scraper blades, scraper carriages, guide rail, drive track, supports, anchor bolts, and all other appurtenances specified or otherwise required for proper operation. Each float scraper shall be suitable for installation in rectangular concrete basins and shall be mounted above the DAF basin.

1.3 Float Beaches

.1 Each float beach shall be supplied completed with all necessary anchor bolts and appurtenances required for connection to the DAF basin wall.

1.4 Saturator Vessels

.1 Saturator vessels of either a packed or an unpacked design may be considered acceptable as part of the DAF equipment package. However, in recognition of the reduced efficiency of an unpacked bed saturator design, any unpacked saturator will be evaluated on a life cycle cost basis using an assumed saturator efficiency of 65% to calculate power costs for recycle pumping, unless the bidder can furnish independently verified evidence that a higher efficiency is achievable. The Contract Administrator reserves the rights to request details of the proposed saturator design during the tender phase.

.2 Each saturator vessel shall be supplied complete with pressure regulating valve, level indicating transmitter, sight glass, pressure gauge, pressure transmitter, temperature transmitter, pressure relief valve, access hatches, lifting lugs, anchor bolts, and all other appurtenances specified, indicated on the Drawings, or otherwise required for proper operation.

.3 In addition, the following items shall be included if a packed bed saturator is offered: packing, packing support grating, and at least two flanged packing removal ports for access to and removal of the packing.

1.5 Recycle Injection Headers

.1 Each recycle injection header shall include recycle drop piping downstream of the recycle shutoff butterfly valves, header piping, flanges, nozzles, pipe supports, and all accessories and appurtenances specified, indicated on the Drawings, or otherwise required for a complete, properly operating installation.

1.6 Dissolved Air Flotation Compressor Packages

.1 Each DAF compressor package shall be supplied complete with compressor, piping, valves, electric motor, motor starter, belts, sheaves, safety guards, receiver, filters, cooling/lubrication system, air/oil separator system, safety devices, controls, vibration pads, anchor bolts, and all accessories and appurtenances specified or otherwise required for proper operation. All equipment shall be mounted on the receiver except for the remote particulate and oil removal filters.

.2 All required interconnecting air piping and valves between package components shall be supplied.

.3 All compressed air supply piping and necessary shutoff and isolation valves needed for a complete, properly operating installation will be sized by the DAF Equipment Manufacturer and supplied by the Contractor.

1.7 Float Trough, Sidewall, and Headwall Spray Wash Headers

.1 Each basin shall include automated spray headers for the float collection trough, headwall, and each sidewall of the basin.

.2 Each spray wash header shall include one spray wash control valve with timer, all supply and header piping downstream of the spray wash control valve, spray nozzles, pipe supports, and all accessories and appurtenances specified, indicated on the Drawings, or otherwise required for a complete, properly operating installation.

1.8 Effluent False Floor or Perforated Pipe Laterals

.1 Each basin will be provided with either a perforated effluent false floor (high rate DAF) or a set of perforated effluent collection laterals (conventional) DAF, complete with all supports necessary.

1.9 Recycle Pumps

.1 The recycle pumps, which shall also be supplied by the Contractor as part of the DAF clarifier system and installed by the Installer, are specified in this Section.

.2 The Contractor is advised that the recycle pump operating conditions specified in this Section are intended to be approximate. The Contractor shall be responsible for selecting and properly sizing a recycle pump which is in general accordance with the requirements of **Section 11300**, and is suitable for installation and continuous operation in the proposed installation depicted in the Drawings included with in these design documents, and including any and all head losses through elements of the recycle system as specified herein, as well as interconnecting piping (see Part B of this Bid Opportunity for pipe sizing for interconnecting piping).

1.10 Saturator Pressure Retention Valves

.1 A saturator pressure retention valve shall be supplied, to be mounted on the discharge of **each** saturator. This valve will automatically close on power failure, to avoid de-pressurization of the saturator.

1.11 Dissolved Air Flotation Control Panels

.1 The Contractor shall supply DAF control panels 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 DAF system.

2. GENERAL

.1 Equipment supplied under this Section shall be fabricated, assembled, and erected in full conformity with Drawings, Specifications, engineering data, instructions, and

recommendations of the DAF Equipment Manufacturer unless exceptions are noted by the Contract Administrator.

2.2 General Equipment Stipulations

.1 **Section 11000 -** The General Equipment Provisions shall apply to all equipment supplied under this Section.

2.3 Power Supply

.1 Power supply for all process equipment shall be either 600 Volts, 60 Hz, three (3) phase, or 110 Volts, single phase for low voltage equipment.

2.4 Equipment Identification

.1 Nameplates

.1 All equipment and valves supplied with the DAF 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.

2.5 Coordination

.1 All equipment in this Section shall be supplied by or through a single supplier who shall have full responsibility for the design, fabrication, coordination, and testing of the DAF system. The Contractor shall verify that each component of the DAF system is compatible with all other components of the system, that all pump, saturator, compressor, motor, valve and pipe materials and sizes are appropriate, and that all devices necessary for proper operation of the system have been provided. The Contractor shall coordinate the items of equipment, appurtenant systems, interconnecting piping, and controls to ensure the compatibility and proper operation of all items.

.2 The Contractor shall provide any additional equipment and piping sizes or materials necessary to meet the performance requirements specified herein and as acceptable to the Contract Administrator. All changes to the DAF system specified and indicated on the Drawings shall be included in the quotation and shall be coordinated by the Contractor.

.3 The Contractor shall prepare system installation Drawings, interconnecting diagrams, panel layouts, and other data required for complete system description and installation.

.4 The Contractor shall also be responsible for start-up and operation and maintenance personnel training for all equipment in this Section, including the recycle pumps.

.5 The DAF system shall be designed to be compatible with the preceding chemical addition and raw water treatment processes of flash mixing using jet diffusion, and vertical flocculation. The Contractor shall verify that the combination of chemical addition in the dosage ranges available, jet diffusion flash mixing, vertical flocculation, and dissolved air flotation will meet the performance requirements, as it is expected that the Contractor will guarantee the performance of the DAF process, in full knowledge of the processes preceding it.

3. SPARE PARTS

.1 Spare parts shall be suitably packaged in accordance with the Equipment General Provisions Section, with labels indicating the contents of each package. Spare parts shall be delivered to the City as directed.

3.1 Recycle Injection Nozzles

.1 Provide one (1) complete set of spare nozzles, sufficient for one (1) entire basin

3.2 Float Scrapers

.1 The following spare parts shall be supplied:

Part Description	Number Required
Complete scraper drive, including motor, gear reducer, and adjustable speed drive.	1
Nylon scraper blades [one (1) set].	8
Clutch block and plastic glides [one (1) set].	2
Guide rail rollers.	48

3.3 Saturator Vessels

.1 The following spare parts shall be supplied:

Part Description	Number Required
Alarm switch.	2
Level controller.	1
Level indicating transmitter.	2
Pressure transmitter.	1
Mass transfer packing.	Sufficient volume for one saturator.
Temperature sensor.	1

3.4 Dissolved Air Flotation Compressor Packages

.1 The following spare parts shall be supplied for the DAF compressor packages:

Part Description	Number Required
Intake air filter elements.	6
Inlet valve assembly.	1
Air-oil separator filter element.	6
Compressor oil filter.	6
Line mounted oil removal filter elements.	2 of each type.
V-belts, matched sets.	6
Food grade lubricant in fire-safe 5-gallon container.	1

3.5 Dissolved Air Flotation Recycle Pumps

.1 Provide spare parts in accordance with the recommendations of the pump manufacturer, but provide at least the following spare parts:

.1 One (1) mechanical seal

.2 One (1) casing wearing

.3 Two (2) sets of all gaskets, seals, and O-rings

4. ACCEPTABLE PRODUCTS

4.1 Primary Dissolved Air Flotation Package Manufacturer

.1 The DAF equipment package shall be as manufactured by one of the following acceptable Manufacturers:

.1 Infilco-Degremont, Montreal, QC – AquaDAF^{TM} – High-Rate DAF.

.2 The F.B. Leopold Company, Zelionople, PA- Conventional DAF.

.3 Parkson Corporation, Fort Lauderdale, FLA- Conventional DAF.

4.2 Dissolved Air Flotation Compressor Packages

.1 The compressors shall be as manufactured by Gardner-Denver, Ingersoll-Rand, Kaeser, Quincy, or equal. Each unit shall be suitable for installation in the space and in the orientation indicated on the Drawings.

.2 Oil-removal filters shall be as manufactured by Zurn or equal.

4.3 Recycle Pumps

.1 See **Section 11300** – Pumps, General, and the specific pump requirements specified herein

5. EQUIPMENT CONSTRUCTION

5.1 General

.1 Fabrication

.1 Welded joints shall be sealed watertight with continuous welds. Fillets and corners must be accessible for grinding. Bolts that are provided at connections to facilitate field weld joints shall be removed and the holes shall be plug welded before painting. All metal contact surfaces of bolted joints, except flanged joints, shall be given a Shop primer coat of rust-inhibitive primer prior to bolting joints together and applying finished Shop paint to bolting joints together and applying finished Shop paint to any completed assembly. Field welding of galvanized steel will not be allowed.

.2 Edge Grinding

.1 Edges and fillets shall be ground to a smooth radius of a least 3 mm to ensure satisfactory paint adherence.

.3 Surface Preparation

.1 In preparation for painting, all welds shall be thoroughly cleaned, ground smooth, and blended with the base metal to eliminate edges in acceptance with National Association of Corrosion Engineers (NACE) Standard RP0178-91 Appendix C, Designation C. Iron and steel surfaces, except motors and speed reducers, shall be solvent cleaned in accordance with Steel Structures Painting Council (SSPC) - SP1 before Shop primer is applied.

.4 Shop Painting

.1 All iron and steel surfaces, except motors, speed reducers, and stainless steel, shall be liquid-epoxy coated to American Water Works Association (AWWA) C210. Use Devoe BAR-RUST 233H applied at a minimum dry film thickness of 16 mils.

5.2 Float Scrapers

.1 General Description

.1 The float scraper guide rails shall be placed longitudinally in the basin and supported from above by crossing supports. The crossing supports shall be bolted to the guide rail and bolted to the tops of the basin side walkways (supplied under a separate Contract) with base plate connections and indicated on the Drawings. The carriage shall be attached to the guide rail in a manner producing free movement along the entire length

of the guide rail. The blade shall be mechanically attached to the carriage. The drive track shall be placed inside the guide rail and rigidly attached to the electric motor.

.2 The scraper blade situated closest to the dewatering beach, which is the only blade that contacts the beach, shall be fitted with nylon brushes, to allow drainage of water as the float is scraped up the beach. The blade shall be designed to move gradually and smoothly up the slope of the beach to facilitate drainage and to avoid splattering of float from the nylon bristles due to backlash.

.2 Drive Units

.1 Drive units shall be designed for the specific requirements of float scraper service and shall be suitable for twenty-four (24) hour-a-day operation under moderate shock conditions. Drive units shall be selected, designed, and rated in accordance with appropriate American Gear Manufacturer's Association (AGMA) standards and shall meet the requirements specified in **Section 11000 -** Equipment General Provisions.

.2 The drive units shall be mounted on the operating floor adjacent to the DAF basins in the location indicated on the Drawings and shall be accessible from the operating floor. Any modifications in the basin guardrail required to accommodate the drive units shall be made at the expense of the Contractor.

.3 The Contractor must be able to demonstrate that the scraper design offered has been in use successfully at least two (2) other facilities for a period of not less than five (5) years. Determination of the final acceptability of the proposed scraper design shall be at the discretion of the Contract Administrator.

.3 Gear Reducers

.1 Gear reducers shall be totally enclosed units with oil or grease lubricated, rolling element, anti-friction bearings throughout.

.2 Each lubrication system shall be provided with an external, visual method of checking lubricant level, without removing parts or fittings. Lubrication shall be accomplished by means of readily accessible oil fill and drain plugs and grease fittings that do not require the removal of parts or dismantling of equipment. Oil drain and fill openings shall be easily accessible from the operating floor, convenient for collection of oil in containers from the floor, without removing the unit from its normal installed position.

.4 Variable Speed Drive

.1 The float scraper unit shall be provided with a variable speed drive system with remote speed control capability from the local control panel. Speed adjustment shall be electronic with a VFD. Mechanical adjustable speed drives will not be acceptable.

5.3 Float Beaches

.1 A float beach shall be supplied at the downstream end of each DAF basin. The angle of incline and length of float beach shall be compatible with the float scraper design and operation and with the DAF basin operating water level range. Anchor bolt connections of float beach to the basin concrete wall shall be supplied.

5.4 Saturator Vessels

.1 The saturator vessel supplied for each pair of DAF basins shall be vertical pressure vessels mounted on legs with base plates and provided with flanged top inlet and bottom outlet connections as indicated on the Drawings, as well as threaded connections for air inlet, level control, sight glass, level element, and pressure relief valve. The vessels shall be designed and constructed in accordance with the American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels and shall bear the ASME Code stamp. Each tank shall be inspected and certified for use under at least the specified maximum design pressure.

.2 The sight glass shall be provided with protector rods, and isolation valves at top and bottom, to allow the glass to be removed for maintenance without draining the saturator. A magnetic float level element, complete with level transmitter, shall also be provided on each saturator vessel.

.3 Each saturator vessel shall be provided with at least one (1) 600 mm diameter, hinged access hatch, to allow access to the saturator internals for maintenance. A single access hatch is considered sufficient for an unpacked saturator, but two (2) hatches shall be provided for a packed bed saturator. For packed bed vessels, one (1) access hatch shall be located below the packing support tray, and the second hatch shall be located above the packing bed.

.4 Packed bed saturator vessels shall have two (2) 250 mm packing removal ports as indicated on the Drawings.

.5 Lifting lugs for lifting the saturator vessels shall be provided at locations indicated on the Drawings. Lifting lugs shall be designed for all possible loads (dead load equivalent to saturator dry weight including packing) including impact. Possible loads include, but are not limited to, the following:

.1 Loads incurred by lifting the saturator vessel vertically (parallel to longitudinal saturator axis) with a lifting cable attached to the two (2) top lugs.

.2 While saturator vessel is hanging from the two (2) top lugs, loads incurred by rotating the saturator vessel bottom up with a cable attached to the lower lug until the saturator vessel longitudinal axis is in a horizontal position.

.6 At the minimum, each lifting lug shall be designed to withstand two times the saturator dead load applied in any direction. The vessel shall be designed for worst-case load combinations from either the specified minimum lifting lug loads or calculated lifting lug loads being applied at any two lugs simultaneously.

.7 Saturator vessel support legs with base plates and anchor bolts shall be provided. The support legs and their connections to the vessel and the support piers shall be designed for the following loads:

.1 Dead load plus live load with saturator vessel completely full of water.

.2 Worst-case lateral load due to either a 25 kg/m^2 lateral load applied on the vertical projected area of the tank or a seismic lateral load calculated and applied in accordance with local Building Codes.

.8 Each saturator vessel shall be provided with a support grating for the packing bed suitable for handling all loads anticipated during operation.

.9 A suitable means of evenly distributing the recycle flow across the superficial area of the vessel shall be provided, utilizing sprays, perforated plates, or trays. It is the responsibility of the Contractor to confirm the impact of the flow distributor selected upon the overall total dynamic head (TDH) characteristics of the recycle pump.

5.5 Recycle Injection Headers

.1 Dual recycle injection headers shall be provided in each DAF basin to evenly distribute recycle flow across the width of the basin. One (1) of the headers will possess $^2/_3$ of the total nozzle orifice area, while the other header possesses the remaining $^1/_3$ to allow the capability to provide 33%, 67%, or 100% of the design recycle flow. Nozzle size and spacing shall be determined by the DAF Equipment Manufacturer. The individual nozzles shall be evenly spaced along the headers.

.2 The recycle drop piping and recycle injection header arrangement shall be reviewed and modified if required by the DAF Equipment Manufacturer in order to meet the performance requirements stipulated herein and to allow convenient access into the DAF basins for maintenance without damage to the nozzles.

5.6 Dissolved Air Flotation Recycle Pumps

.1 The recycle pumps shall be horizontal, split-case centrifugal pumps, or approved substitute horizontal style pump. Approval of proposed substitute pump types shall be requested by the Contractor during the bid submission phase as specified in clause B5 of this Bid Opportunity.

.2 The manufacturer shall confirm all performance requirements to be compatible with the requirements of the DAF system, to meet the operating and performance requirements specified herein. The performance requirements listed herein are to be considered approximate. It is the responsibility of the Contractor to ensure selection of a pump compatible with the requirements of the DAF system**.**

.3 Each recycle pump shall be fitted with a variable frequency drive (VFD), suitable for operation as proposed herein. All motors and VFD's shall be in accordance with Section 11060 – Process Motors less than 150 kW, and 16815 – Variable Frequency Drives, respectively;

5.7 Dissolved Air Flotation Compressor Packages

.1 Each compressor will be a single stage, heavy duty, oil flooded and air cooled, asymmetrical lobe, rotary-screw type. Each unit shall be equipped with tapered roller bearings on the discharge and cylindrical roller bearings on the inlet end for high load carrying capacity. Each unit shall be designed for operation with food grade lubricant.

.2 Each compressor shall be mounted on its air receiver in the manner recommended by the compressor Manufacturer. The package shall be designed so that compressor vibration is not transmitted to the receiver.

.3 The DAF compressor packages shall provide smooth, pulse-free operation and shall be designed for continuous duty operation.

.4 Air Compressor Modules

.1 Each compressed air module shall consist of, but shall not be limited to, an inlet air filter, inlet throttling valve, compressor, motor, belt drive with guard, air/oil separator reservoir, air-cooled oil cooler, air-cooled aftercooler, separator, controls, control panel, enclosure, base, valves, piping, and unloading system.

.2 The air compressor module components shall be standard Products of the DAF Equipment Manufacturers. The modules shall be completely factory assembled requiring only field connection of electrical power, air, and condensate drain piping.

.5 Bearings

.1 Bearing shall be anti-friction with an ABRMA B-10 life of 80,000 hours.

.6 Air Inlet Filter

.1 The air inlet filter shall be suitable for easy cleaning and replacement.

.7 Receiver

.1 Each receiver shall be a horizontal tank of all welded construction with semi-ellipsoidal heads and leg supports for mounting on a concrete base. Each receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the ASME code stamp.

.2 Each receiver shall be provided with piping connections for an inlet, outlet, drain, safety valve, receiver vent, pressure gauge, pressure switch, compressor control, and inspection opening. Each receiver shall have an automatic float-operated condensate drain trap.

.3 Each receiver shall be supplied with a pressure gauge, safety valve, and vent valve. An additional the pressure gauge shall be located in the control panel.

.8 Cooling/Lubrication System

.1 The heat of compression from the compressor shall be removed by lubricant which is re-circulated through an air-cooled heat exchanger and fluid with internal bypass.

.2 Cooling/lubrication system equipment shall include fan mounted on the motor shaft, full-flow fluid filter, fluid thermal bypass valve, and air cooled aftercooler.

.9 Air/Oil Separator System

.1 The unit shall be designed with internal cavities for the separator and sump and shall be fitted with an ASME pressure relief valve, fluid level sight glass, easily replaceable high efficiency multi-stage air/oil separator element, combination minimum pressure and discharge check valve, and inlet control valve. The maximum oil carryover from the compressor oil separator shall not exceed 2 ppm by weight.

.10 Safety Devices

.1 Each compressor shall be fitted with an air/lubricant high temperature switch, high air discharge pressure switch, motor overload protection, and sump pressure relief valve. All safety relief valves recommended by the compressor Manufacturer shall be provided.

.11 Enclosures

.1 Each compressor and all its accessories and appurtenances shall be completely enclosed within an acoustic enclosure. The enclosures shall be sheet metal with acoustic lining designed to reduce noise levels below 80 dB at one meter. The enclosure shall provide adequate ventilation and easy access to all maintenance items within the enclosure.

.12 Package Piping and Valves

.1 All interconnecting piping and tubing between components of the equipment package shall be Shop installed.

.2 Piping from the compressor discharges to the receiver shall be sized not less than the compressor discharge connection size and shall be hard drawn copper tubing.

.3 Pneumatic control and instrument tubing connected directly to the compressor shall be ASTM A269, Type 304 or 316 stainless steel tubing with Parker Hannifin “CPI” or Crawford “Swagelok” Type 316 stainless steel compression fittings. Tubing shall be not less than 6 mm O.D. with a wall thickness of 0.7 mm.

.4 All piping and tubing shall be run in vertical and horizontal planes. Piping shall be arranged to ensure that undue stresses from thermal expansion are not transmitted to equipment components. All control and instrument tubing shall be continuously supported.

.5 Compressor discharge piping shall be sloped to drain to the receiver or shall include drip traps to prevent condensate in the discharge piping from draining back to the compressor.

.6 Air piping between the compressor packages and the saturator vessels shall be sloped to drain either to the receivers or saturator vessels, or drip legs shall be provided.

.7 Condensate drainlines from each compressor and receiver shall be piped to floor bellups.

.8 Pressure relief/control valves shall be forged steel, with Viton or Ethylene Propylene Diene Monomer (EDPM) diaphragms, suitable for hot air service. Ball valves shall be brass with Teflon seats and seals. Pneumatic control valves shall be stainless steel. The discharge check valves shall be bronze.

5.8 Oil-Removal Filters

.1 Coalescing filters, carbon filters, and particulate filters shall be supplied. Each filter shall be supplied with a differential pressure indicator to signify the need of service or replacement of the elements. Each filter shall be supplied with an automatic float-operated condensate drain trap.

5.9 Spray Wash Headers

.1 Two (2) discrete spray wash header systems shall be provided within each DAF basin, one system to spray each of the side walls, and a second to spray the float trough, and prevent accumulation of float deposits on the trough walls. Design of the spray wash header shall be by the Contractor and shall conform to the requirements in this Section.

.2 The float trough spray header shall be configured to provide a flushing flow of no more than 75 L/min per trough and shall provide complete coverage of the surface areas of the trough.

.3 Each sidewall spray header shall be configured to provide a flushing flow of no more than 75 L/min per sidewall, and shall provide complete coverage of the full length of the DAF basin.

6. SERVICE CONDITIONS

.1 The DAF clarifier equipment shall be used to clarify raw water originating from Shoal Lake, which has been flocculated using ferric chloride, preceded by pH adjustment using sulphuric acid. Flocculant aid polymer may also be used if DAF loading rates in excess of 18 m/hr are used.

6.1 Water Characteristics

.1 Characteristics of the raw water are as follows:

Parameter	Range	
	Average	Minimum/Maximum
Temperature, ^oC.	7^oC	0.5 to 20^oC
Turbidity, NTU.	1.0	0.25 to 10
True Colour, TCU.	< 5	< 5 to 10
Total Organic Carbon, mg/L.	9.3	5 to 17
Dissolved Organic Carbon, mg/L.	8.3	4 to 15
Total Alkalinity, mg/L as $CaCO_3$.	81	72 to 95
pH.	8.2	7.0 to 9.2
Algae, number/mL.	37,500	200 to 1,000,000

.2 The following chemicals applied at or before the in-line mixers will be available between the dosage ranges specified:

Chemical	Chemical Concentration (mg/L)	
	Average	Maximum
pH Adjustment – Sulphuric Acid.	35 as H_2SO_4	45 as H_2SO_4
Coagulant – Ferric Chloride.	35 as $FeCl_3$	50 as $FeCl_3$
Flocculant Aid - Cationic Polymer (if used).	0.060	0.075

.3 The DAF clarifier equipment must be compatible and corrosion resistant to any combination of the following chemicals:

Location of Chemical Feed	Chemical
Influent Flash Mixing:	Ferric chloride, cationic coagulant aid polymer, sulphuric acid.
Flocculation Cell No. 2	Flocculant Aid Polymer.

7. PERFORMANCE AND DESIGN REQUIREMENTS

7.1 Design Requirements

.1 The DAF systems shall be designed for the following requirements:

Design Requirements	Total
Number of DAF basins, total.	8
Number of DAF basins per train.	4
Total minimum design flow, without recycle, ML/d.	100
Total operating flow range, without recycle, ML/d.	100 to 409
Maximum design flow per basin, without recycle, ML/d.	52.25
Operating flow range per basin, without recycle, ML/d.	26.13 to 52.25

7.2 Performance Requirements

.1 The DAF systems shall be designed to meet or exceed the following DAF effluent criteria at the design surface loading rate:

DAF Effluent Criteria	Design Surface Loading Rate
Average daily turbidity, NTU[1].	<1.5 NTU during 95% of basin operation or 50% reduction of the influent turbidity, the more stringent requirement shall apply. Never > 2.0 NTU.
Algae, percent removal.	> 90% during 95% of basin operation.

Note: [1] NTU – Nephelometric Turbidity Units

7.3 Dissolved Air Flotation Basin

Parameter	High Rate	Conventional
Surface loading, without recycle, m/hr	36	18
Side water depth, metres	5.5	2.5
Total side wall depth, metres	6.0	3.0
Length, including recycle injection zone, metres	6.04	11.0
Width, metres	10.0	11.0
Maximum recycle flow, % of design flow	10.0	10.0

7.4 Float Scrapers

Scraper type	Mechanical, reciprocating
Minimum length of DAF basin scraped, metres.	4.0 m high rate/7.5 m conventional.
Maximum blade spacing, metres.	2.0
Drive type.	Electric, variable speed.
Minimum range of scraper speeds.	125 to 2,000 mm/min Note: Speed to be adjustable independently in both forward and reverse directions.
Maximum DAF basin water level variation, millimetres.	Zero variation in level, over a range of flow through the basin of 50% to 150% of design capacity. Provide a level control system to ensure this control.

7.5 Saturator Vessels

Vessel type & diameter, metres (See note 1)	2.6 (102 inch nominal diameter) ASME Standard Pressure Vessel.
Vessel total height, metres.	4.3
Design superficial loading, $m^3/m^2/d$.	2,000 at 10% recycle.
Saturator packing depth, metres. (if used, See Note 2)	1.2
Saturator packing type (if used, See Note 2)	25 mm nominal diameter polypropylene Pall Rings, Raschig Rings, Jaeger Tri-Packs or acceptable alternative.
Operating pressure range, kPag.	400 to 600
Minimum vessel design pressure, kPag.	1,400
Minimum Saturator Outlet Diameter, mm.	450
Minimum Operating Depth of Water "Pool" in Base of Saturator (See Note 3)	900 mm

Notes: 1. Alternative designs for an unpacked saturator may be considered acceptable, but shall be subject to review and approval by the Contract Administrator as part of the tender process.

2. These criteria are only to be met if a packed bed saturator is supplied under the Contract.

3. The "depth of water pool" in the saturator is defined as the depth of water in the base of the saturator under normal operating conditions. The recycle pumps feeding each saturator will normally be controlled to ensure a constant water level in the base of the saturator. The depth of water between the set point operating water level and the entrance to the saturator discharge piping must be at least as specified in the table above, to control the potential for vortexing.

7.6 Recycle Injection Headers and Nozzles

Number per basin.	2
Header diameter, mm.	
67% recycle flow header.	200
33% recycle flow header.	150
Nozzle type.	Fixed orifice
Maximum nozzle spacing, mm.	200

.1 The fixed orifice nozzles shall be generally designed to include a stainless steel orifice plate, plus an impingement plate fixed in position downstream of the orifice opening, to induce bubble shear and maximize the formation of bubbles in the 20 to 100 micron size range. While it is recognized that formation of some bubbles larger than this ideal range is inevitable, the nozzle design shall not produce an excessive quantity of large bubbles.

7.7 Recycle Pumps

.1 The recycle pumps shall be suitable for long-term operation under the following conditions:

Pump Duty	Continuous
Pump Drive	Variable speed
Ambient environment	Indoors
Ambient temperature, (°C)	10 to 25
Ambient relative humidity (%)	20 to 100
Fluid service	Clarified DAF subnatant
Fluid temperature, (°C)	1 to 20
Fluid pH range	5.0 to 8.5
Fluid specific gravity	1.0
Fluid viscosity (Centipoises @ 20 °C)	1.12
Minimum available net positive suction head (NPSH) (m)	15
Drive:	Direct drive with heavy duty, horizontal, electric motor suitable for 600 volt, 3 accordance with **Section 11060** – Process Motors under 150 kW.

.2 Performance Requirements:

.3 Note: Manufacturer shall confirm all performance requirements to be compatible with the requirements of the DAF system. The performance requirements listed herein are to be considered approximate. It is the responsibility of the Contractor to ensure selection of a pump compatible with the requirements of the DAF system, see **Section 11490 -** Dissolved Air Flotation Clarifier Equipment**.**

Maximum shutoff head (m)	80
Design flow capacity (L/s)	121 or sufficient to ensure a 10 g/m^3 air loading at 20°C and 590 kPag saturator pressure using the type of saturator proposed (see Note 1) – whichever is greater
Design flow pump head [total dynamic head (TDH) m]	65
Design flow minimum pump efficiency (%)	75
Maximum flow capacity at maximum speed (L/s)	150
Maximum flow pump head (TDH m) plus and minus 1 m	55
Maximum flow minimum pump efficiency (%)	70
Maximum flow NPSH required (m)	12
Minimum flow capacity at maximum speed (L/s)	100
Minimum flow pump head (TDH) at maximum speed (m) plus and minus 1 m	80
Minimum flow pump efficiency (%)	70
Maximum pump speed (rpm)	1,150
Maximum motor speed (rpm)	1,800
Minimum motor size (kW)	100

Note: 1 Packed saturators will be granted an efficiency of 95% for the purposes of this calculation. Any unpacked saturators will be granted an efficiency of 65% for the purposes of this calculation, unless a higher efficiency can be demonstrated. Air loading will be calculated as documented in the Bid Evaluation section of this Bid Opportunity.

.4 Pump Dimensions:

Impeller diameter, min (mm)	8.5
Suction flange, min size (mm)	400
Discharge flange, min size (mm)	300
Suction flange rating, American National Standards Institute (ANSI) (psi)	125
Discharge flange rating, ANSI (psi)	125

.5 Pumps shall be controlled in accordance with the Specifications of Division 17, Instrumentation & Controls (I&C).

.6 Pumps shall be manufactured by one of the following approved manufacturers: Aurora Pump, Peerless, Cornell, Ingersoll-Dresser, PACO

7.8 Dissolved Air Flotation Basin False Floor (High-Rate Only)

.1 Supply a perforated false floor for each DAF basin, arranged as shown generally in the Drawings. The design and layout of false floor perforations must provide for the distribution of subnatant withdrawal required for optimal operation of the basins.

.2 The DAF basin false floor shall be marine grade aluminum, or stainless steel. For the selected false floor, the DAF Equipment Manufacturer shall provide a written statement confirming the corrosion resistant of the selected material given the chemicals being used for the treatment process.

.3 It is recognized that the false floor will introduce hydraulic head loss as water flows through it during normal operation. Since it is intended that the DAF basin will be operated over a normal operating range of 50 to 100% of design capacity, and possibly up to 150% of design capacity under emergency conditions, this head loss will vary with flow, and would result in an excessive variation in water level in the basins, unless the water level were controlled. The Contractor shall therefore supply a basin level control mechanism to control basin water level at a constant across the full 50 to 150% flow range. This shall include a level controller within the DAF basin effluent weir chamber, bypass gate or valve to be mounted within the effluent weir wall (to allow flow to bypass the weir in sufficient quantity to maintain water level variation within specified limits), actuators, and all controls to permit this level control to operate across the full range of basin design flows.

7.9 Perforated Pipe Laterals (Conventional DAF only)

.1 Provide a set of perforated pipe laterals for each DAF basin, arranged as shown generally in the Drawings.

.2 It is recognized that the perforated pipe laterals will introduce hydraulic headloss as water flows through it during normal operation. Since it is intended that the DAF basin will be

operated over a normal operating range of 50 to 100% of design capacity, and possibly up to 150% of design capacity under emergency conditions, this head loss will vary with flow, and would result in an excessive variation in water level in the basins, unless the water level was controlled. The Contractor shall therefore supply a basin level control mechanism to control basin water level at a constant across the full 50 to 150% flow range. This shall include a level controller within the DAF basin effluent weir chamber, bypass gate or valve to be mounted within the effluent weir wall (to allow flow to bypass the weir in sufficient quantity to maintain water level variation within specified limits), actuators, and all controls to permit this level control to operate across the full range of basin design flows.

7.10 Dissolved Air Flotation Compressor Packages

Ambient conditions.	
Air temperature, ºC.	
Maximum	30°C
Minimum	15°C
Relative humidity, percent.	Minimum 30%, Maximum 80%
Site Elevation.	236.5 metres a.s.l

7.11 Compressor

Number required.	2
Number of Duty Compressors.	1 total
Number of Standby Compressor for all DAF basins.	1 total
Unit designation.	To be confirmed.
Discharge pressure, kPag.	860
Minimum inlet capacity of each compressor when operating at the specified discharge pressure, Sm^3/hr.	435
Maximum brake horsepower, bhp.	Non-overloading throughout operating range. No use of the motor service factor is permitted.
Minimum Motor size, kW.	40
Maximum motor speed, rpm.	3,600
Air inlet filter:	
Type.	Single stage, dry
Maximum particulate size passing filter, microns.	10
Cooling/lubrication system:	
Aftercooler Maximum discharge air temperature, ºC.	48
Air/oil separator system:	
Minimum design pressure, kPag.	1,200
Maximum discharge entrained oil concentration at the compressor package discharge, ppm.	1
Receiver**:**	
Number required.	2
Minimum design pressure, kPag.	1,400
Minimum nominal volume, litres.	500

7.12 Oil Removal Filters

Type	Particulate	Coalescing	Carbon
Unit designation.	To be confirmed	To be confirmed	To be confirmed
Number required.	Two (2) per train [four (4) total]	Two (2) per train [four (4) total]	Two (2) per train [four (4) total]
Min. capacity, each, Sm^3/hr.	500	500	500
Min. design pressure, each, kPag.	860	860	860
Max. initial pressure drop, kPag.	35	35	35
Efficiency.	70% on 1 micron	99.999% on 0.25 micron	Oil content to 0.003 ppm

8. MATERIALS OF CONSTRUCTION

8.1 Float Scrapers

.1 The following materials of construction are to be used in the manufacture of the float scrapers.

Supports, guide rail, carriage and drive track.	Aluminum, or hot-dip galvanized steel in accordance with ASTM A153 and A385, or Type 304 stainless steel.
Scraper Blades:	
Metal components.	Aluminum, hot-dip galvanized steel in accordance with ASTM A153 and A385, or Type 304 stainless steel.
Wiper.	Neoprene.
Bristles.	Nylon, provided for blade contacting dewatering float beach only.
Solid Shafts.	Cold rolled Type 304 stainless steel.
Couplings:	
Pins and setscrews.	AISI Type 304 stainless steel.
Bolts and nuts.	AISI Type 304 stainless steel.
Scraper Flights:	
Bolts, nuts, and washers.	AISI Type 304 stainless steel, elastic locknut type with nylon insert.
Bearings:	
Submerged.	Water lubricated, babbitt or Ryertex.
Non-submerged	Grease lubricated, babbitt or bronze, with grease fitting.

8.2 Float Beaches

.1 Float beaches shall be constructed of Type 304 stainless steel. All anchor bolts shall be stainless steel.

8.3 Saturator Vessels

.1 The following materials of construction are to be used in the manufacture of the saturator vessels.

Saturator vessel shell and support legs.	
Steel plate and shapes.	ASTM A36.
Interior lining.	Epoxy coated to AWWA C210.
Saturator packing.	25 mm polypropylene Pall or other appropriate mass transfer packing.
Support grating.	Type 316 stainless steel to ASTM A314 or equivalent corrosion-resistant material.
Sprays, perforated plates, pipes, or trays for recycle flow distribution.	Type 316 stainless steel to ASTM A314 or equivalent corrosion-resistant material.

.2 All components in contact with water or vapour shall be Type 316 stainless steel or equivalent corrosion resistant materials.

.3 The Contact Administrator reserves the right to request details of the proposed saturator design during the bid evaluation phase.

8.4 Recycle Pumps

.1 The following materials of construction are to be used in the manufacture of the recycle pumps.

Casing	Cast iron ASTM A48
Pump base	Cast iron or steel base plate with drain rim or pan
Impeller	Bronze ASTM B 584 statically and dynamically balanced, enclosed
Case wear ring	Bronze ASTM B 62, B 271, or B584
Shaft	Steel AISI C1045 or SAE 1112 or 4140, designed for max 0.002-inch deflection at sealing face at max load
Shaft sleeve	Bronze ASTM B 62, B271, or B584
Seal	Mechanical seal
Mounting	Close-coupled
Bearings	Ball bearings as specified in **Section 11060** - Process Motors under 150 kW
Lubrication	Grease

8.5 Recycle Injection Headers

.1 Recycle drop piping and injection header piping shall be Type 316 stainless steel. Nozzle internals shall be Type 316 stainless steel.

8.6 Spray Wash Headers

.1 The following materials of construction are to be used in the manufacture of the spray wash headers:

Piping.	PVC, Schedule 80.
Nozzles, valves.	Type 316 stainless steel.

9. OPERATION

9.1 General

.1 The DAF clarifiers will separate turbidity, coagulant-formed floc and algae from flocculated water by flotation. Clarified water shall flow out of the DAF basin through the effluent false floor or perforated pipe laterals, and discharge over the DAF effluent weir into the DAF effluent channel.

.2 The solid particles (DAF float) that accumulate at the DAF basin water surface shall be continuously or intermittently scraped over the float beach into float troughs and will flow by gravity to float sumps. The DAF float will then be pumped to the residuals handling facilities.

.3 The DAF clarifier equipment shall be designed for continuous operation at optimum efficiency between 50 and 100% of design flow. Recycle flow in excess of 10% of DAF basin flow between 50 and 67%t of basin design flow and less than 10% of DAF basin flow above 100% of basin design flow will be acceptable. If DAF basin flow decreases to below 50% of design flow, individual DAF basins and/or one or more trains will be removed from service to increase flow to the basins remaining in service so that DAF clarifier efficiency and capacity is not compromised. The DAF basins have the hydraulic capability to operate between 50 and 150% of design flow, but DAF clarifier performance shall be optimized (and the DAF Equipment Manufacturer responsible for acceptable clarified water quality) between the normal operating range of 50 to 100% of design flow.

9.2 Float Scrapers

.1 Each float scraper shall push float material along the DAF basin water surface in the direction of basin flow and scrape the float up the inclined dewatering float beach and discharge into the concrete float trough.

.2 An electric motor shall provide back and forth movement to a drive track which moves the scraper blade and carriage assemblies forward and backward along the length of the basin.

An eccentric arm shall drive the lever arm in a back and forth motion which pushes and pulls the drive track to move the scraper blade and carriage assemblies along the guide rail. As the carriages move forward, the blades shall push DAF float toward the dewatering float beach at the downstream end of the DAF basin. When the blade closest to the dewatering float beach has traveled up the length of the beach and has reached the limit of travel, all of the scraper blades shall retract above the water surface and the carriages shall reverse their line of action and return to their starting positions. When the carriage closest to the influent end of the basin reaches the starting position, all the scraper blades shall be moved down into the scraper position. The direction of carriage travel shall again reverse to move DAF float toward the float dewatering beach.

.3 The nominal frequency of float scraper operation shall be determined at start-up. The float scraper shall have the capability to run continuously at varying speeds (independently in either direction) within the specified range and to be operated intermittently on an adjustable timed cycle.

9.3 Float Beaches

.1 Float beaches shall be designed such that the DAF basin water surface shall neither submerge the float beach nor fall below the bottom of the float beach between 50 and 150% of basin design flow. A level control system shall be supplied to ensure that operating water level remains constant across the full range of design flows.

.2 The float beach shall not be angled such that float scraped onto the beach falls back in the DAF basin.

9.4 Saturator Vessels

.1 Under normal operating conditions, each saturator vessel will be operated at a constant recycle flow rate and saturator pressure. The pressure regulator on the saturator vessel air supply line shall be used to maintain constant pressure in the saturator. Saturator vessel pressure shall be adjustable.

.2 Recycle water shall be distributed evenly across the superficial area of the vessel, and will become partially to completely saturated with air as it trickles through the bed, or falls into the vessel (depending upon the type of vessel used). As air dissolves into the recycle water, only the volume of air necessary to maintain a constant saturator pressure will be supplied to the saturator vessel. The saturated water shall discharge from the packed bed into a pool inside the base of the saturator vessel.

.3 A level controller (may be stand alone or functionality may be programmed into PLC) at the main control panel shall continually monitor the depth of the pool of saturated water from the level transmitter. The level controller shall provide a control signal to the VFD of the recycle pump feeding the saturator to maintain a constant liquid level in the base of the saturator vessel by varying the recycle pumping rate. If the pool level decreases, the VFD shall increase pump speed to increase the recycle flowrate to the saturator. If the level increases, the variable frequency drive shall decrease pump speed. The level controller shall also include a high and low level alarm contact to operate a remote alarm on high or low

water level. The recycle pump control shall ensure that a sufficient pool of recycle water in the base of the saturator vessel is available for injection at all times. The constant pressure in the saturator and the total recycle injection header nozzle orifice area shall control the constant flow rate of recycle to the DAF basin.

.4 Changes in recycle flow to the basins may be made through a combination of changing saturator operating pressure (using the pressure regulating valve), or by closing one of the recycle injection manifolds, to reduce the number of open nozzles in the basin. either of these actions will result in a short term change in the saturator liquid level. The control system must have sufficient flexibility to quickly adjust the recycle pump speed to re-establish the water level to the set point level after such adjustments have been made.

9.5 Recycle Injection Headers

.1 The recycle injection headers and fixed orifice nozzles shall provide rapid pressure drop and release of dissolved air from the recycle as a cloud of microbubbles. The microbubbles will carry floc and algae to the surface of the DAF basin for removal by the float scraper.

.2 Dual recycle injection headers shall be supplied for each basin as indicated on the Drawings. One injection header shall have 67% of the total nozzle orifice area, and the other injection header shall have 33% of the total nozzle orifice area. Recycle flow may be reduced from 100 to 67% of design recycle flow by closing the injection header with 33% of the total nozzle orifice area.

9.6 Dissolved Air Flotation Compressor Packages

.1 The DAF compressor packages shall deliver compressed air to the saturator vessels. Two (2) [one (1) duty, one (1) stand-by] compressor packages shall be supplied for the entire facility, with the duty compressors each serving four (4) saturation vessels. The stand-by compressor package shall be suitable for serving all saturators. One (1) post-treatment train (particulate and oil filters) shall be supplied for each pair of saturators. One (1) oil removal filter of each type shall be a standby.

.2 DAF Compressor Controls

.1 Each compressor package shall be supplied with a control panel. Each control panel shall have provision for setting load and unload pressures. One (1) compressor per train shall operate as the lead unit and the other as the lag. Alternation between the lead and lag unit will be selected manually at the panel. The lead unit shall be set to load at 720 kPag and unload at 860 kPag. The lag unit shall be set to load at 690 kPag and unload at 825 kPag. The settings shall be adjustable.

.2 Compressor to be fitted with an Computer/Off/Hand (COH) switch to allow for either manual or automatic operation.

.3 All necessary devices shall be provided to allow the compressors to be started either locally or remotely.

.4 Each compressor shall be capable of operating in either a constant run mode, with the compressor loading and unloading as required, or in an auto start, timed stop mode. The timed stop mode shall be capable of limiting motor starts to four (4) per hour. The inlet valve shall allow unloaded operation. Unloaded power consumption shall be minimized. Instrumentation provided with the compressor package shall include, but shall not be limited to, the following:

.1 Indicators:

.1 Discharge air temperature.

.2 Oil temperature.

.3 Discharge air pressure.

.4 Receiver pressure.

.5 Inlet air filter pressure differential/change indicator.

.6 Oil pressure.

.7 Oil filter pressure differential/change indicator.

.8 Oil separator differential pressure/change indicator.

.2 Elapsed Time Meter

.1 .One (1) on each compressor.

.3 Safety shutdowns shall include:

.1 Motor overload.

.2 High discharge air temperature.

.3 High lubricant temperature.

9.7 Spray Wash Headers

.1 An automatic spray wash control valve shall control the operation of the spray wash headers. The automatic spray wash control valve shall be a solenoid valve on each spray wash header. Solenoid valve operation shall be based upon an adjustable timer.

.2 Each of the two headers (float trough, and sidewalls) must each be fitted with a separate solenoid valve and control system, to allow each of the spray headers to be operated independently of each other.

9.8 Saturator Pressure Retention Valves

.1 The saturator pressure retention valve (open/close service) located on the discharge of each saturator shall be interlocked with the recycle pump operation to maintain saturator pressure. When the recycle pump starts, the valve shall automatically open after an adjustable time delay to allow recycle to flow to the DAF basins. Upon shutdown of the recycle pump, the valve shall automatically close to maintain saturator pressure. The valve shall automatically close upon power failure to maintain saturator pressure and prevent depressurization.

9.9 Pressure Regulating Valve

.1 The pressure regulating valve on each saturator vessel air supply line shall be adjustable, so as to allow for the pressure in the DAF saturators to be adjusted in the 400 to 600 kPag range.

9.10 Dissolved Air Flotation Basin Level

.1 A level controller (may be stand alone or functionality may be programmed into PLC) shall be supplied on each DAF basin, to ensure that basin water level remains constant between 50 and 150% of nominal capacity.

.2 The DAF basin effluent weir and the headlosses through the false floor or pipe lateral system determines the DAF basin level for a given basin flow. The level controller shall compensate for these losses to ensure that water level remains constant at all times. Clarified water flows out of the DAF basin through the false floor or effluent laterals and discharges over the DAF basin effluent weir.

10. DRIVE UNITS

10.1 Motors

.1 Each motor shall comply with **Section 11000 -** Equipment General Provisions except as specified herein. Each motor shall be squirrel-cage induction type rated 600 volts, three (3) phase, 60 Hz. Motor bearings shall be re-greasable anti-friction type with L10 life rating of 40,000 hours.

.2 Each motor shall be provided with an open drip proof (ODP) enclosure with lifting lugs.

.3 Each motor shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply. Space heater leads shall be brought out to the motor terminal box for wiring in conduit.

.4 Each motor that will be controlled by a VFD shall be supplied with at least one (1) automatic reset motor winding temperature switch per phase. Temperature switch contacts shall be

wired in series with the end leads brought out to the motor terminal box. Switches shall be as recommended by the motor Manufacturer.

.5 Motors shall be specifically selected for service with a variable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation so that the motor does not exceed Class B temperature rise when operating in the installed condition at load with power received from the VFD. All motors used with VFD's shall be invertor duty rated and supplied full phase insulation on the end turns.

.6 A warning nameplate shall be provided on each motor used with a VFD to warn the operator to trip the main breaker prior to performing maintenance procedures.

10.2 Variable Frequency Drives

.1 VFD's supplied with devices requiring adjustable speed drives shall be coordinated with the requirements for the applicable equipment.

.2 The Contractor shall be responsible for supplying the VFD's. Particular attention shall be directed toward the drive torque requirements. The VFD's shall be a Product of the single VFD Manufacturer.

.3 The Contractor shall be responsible for coordinating the equipment and drive components to assure that a complete and properly operating system is supplied. All equipment shall be derated as recommended by the drive and motor Manufacturers for reduced speed operation with a variable frequency controller in addition to any derating requirements specified elsewhere. The Contractor shall be responsible for the collection of data and the design effort required limiting harmonics.

.4 VFD's shall be provided as specified in this Section of the document and **Section 16815 –** Variable Frequency Drives. If there are any discrepancies between the Specifications, the more stringent requirement applies.

11. INSTRUMENTATION AND CONTROLS

11.1 General

.1 The instrumentation and control system for each DAF train shall be supplied as part of the DAF system.

.2 The Contractor shall supply a main control panel for each process train as specified herein.

.3 Each main control panel will be supplied with a single point power supply and equipment control, equipment status, process variable, and alarm signal wiring to the SCADA system. Each main control panel shall serve as the SCADA system's single point of connection for all equipment and instruments associated with the DAF process. All Inputs/Outputs (I/O) will be monitored by the SCADA system via the main control panel.

.4 For additional instrumentation and controls requirements refer to Division 17 of the document. If there are any discrepancies between the Specifications assume the more stringent requirement applies.

11.2 Discrete Input Points

.1 Float scraper selector switch in "Computer" position - (4)

.2 Float scraper running - (4)

.3 Float scraper motor overload - (4)

.4 Saturator vessel liquid high alarm - (2)

.5 Saturator vessel liquid low alarm - (2)

.6 Saturator vessel pressure retention valve open - (2)

.7 Saturator vessel pressure retention valve closed - (2)

.8 DAF compressor motor overload - (2)

.9 High compressor discharge air temperature alarm - (2)

.10 High compressor lubricant temperature alarm - (2)

.11 DAF compressor running - (2)

.12 DAF recycle pump running - (3)

.13 DAF recycle pump failure - (3)

.14 One (1) basin on line [from selector switch at control station] - (1)

.15 Two (2) basins on line [from selector switch at control station] - (1)

.16 Three (3) basins on line [from selector switch at control station] - (1)

.17 Four (4) basins on line [from selector switch at control station] - (1)

11.3 Analogue Input Points

.1 Saturator vessel temperature - (2)

.2 Saturator vessel pressure - (2)

.3 Saturator vessel liquid level - (2)

.4 Saturator vessel influent flow rate - (2)

.5 DAF recycle pump speed - (3)

11.4 Analogue Output Points

.1 Saturator vessel recycle ratio - (2)

.1 Quantities in parentheses are points per main control panel; point description is with respect to the area programmable logic controller (PLC) serving as the SCADA system interface.

11.5 Miscellaneous I/O Points

.1 In addition to the points listed above, the following typical I/O points shall be wired to the DAF Control PLC.

.1 Full Voltage Non Reversing (FVNR) Motor Starters.

.1 Start Command.

.2 Running Status.

.3 Ready Status.

.2 VFD's.

.1 Speed Control Analogue Output.

.2 Speed Feedback Analogue Output.

.3 Start Command.

.4 Running Status.

.5 Ready Status.

.3 Spring Return Valves and Gates.

.1 Drive (Open/Close) Command.

.2 Limit Switch Status.

.4 Powered Actuators – Non Modulating.

.1 Open Command.

.2 Close Command.

.3 Open Limit Status.

.4 Closed Limit Status.

.5 Ready Status.

.5 Powered Actuators – Modulating.

.1 Position Control Analog Output.

.2 Position Feedback Analog Input.

.3 Open Limit Status.

.4 Closed Limit Status.

.5 Ready Status.

.6 Transmitters.

.7 Process Variable Analog Input.

.8 Fault Status.

11.6 Control Panel Fabrication

.1 Control panel fabrication shall meet the requirements of Division 16 and 17.

11.7 Panel Wiring

.1 All internal instrument and component device wiring shall be supplied by the Contractor. All interconnecting wiring and wiring to terminals for external connection shall be insulated for not less than 600 V.

.2 All electrical components and devices shall be provided and installed in accordance with Specification Division 16 and 17.

11.8 Device Identification

.1 All devices within the panel shall be permanently identified. The device and terminal identifications shall agree with those indicated on the equipment submittal Drawings.

.2 Nameplates shall be provided on the face of the panel or on the individual device as required. Panel nameplates shall be made of laminated phonetic material, white with black lettering. Nameplates shall be secured firmly to the panel.

.3 Instrumentation shall be identified and tagged in accordance with Specification Division 17. Instruments supplied under this Section not already identified by the Drawings and Specifications shall be assigned an identifier by the Contractor and shall be tagged in accordance with Specification Division 17.

11.9 General Instrumentation Requirements

.1 It shall be the responsibility of the Contractor to supply all instrumentation necessary to provide a properly functioning system.

11.10 Main Control Panel Devices

.1 In general, all points listed to be monitored by the SCADA system elsewhere in this Section shall be indicated at the main control panel for each train. Where individual device Specifications exist for a particular instrument in the Instrumentation Section, the instrument shall meet those requirements.

11.11 Interface with the SCADA System

.1 Each main control panel shall be provided with electrical and electronic connection points for the area PLC (which serves as the SCADA system interface) for all points to be monitored by the SCADA system listed elsewhere in this Section. All SCADA system connections shall terminate at terminal blocks specifically dedicated for that purpose. Electrical requirements for points monitored by the SCADA system are as follows:

.2 Discrete Input Points. The interface shall be in the form of isolated, dry, normally-open contact closures from interposing relays or switches supplied with the main control panel. Wetting voltage for the contacts shall originate from the area PLC panel. Contacts shall be rated three (3) amperes minimum at 120 V AC.

.3 Discrete Output Points. The interface shall receive an isolated contact rated at 4A at 120 VAC from the PCL. If the load current is greater than 4A, Install an interposing relay.

.4 Analogue Input Points. The interface shall be an isolated (floating) 4 to 20 ma DC signal linear with the measured process variable and sufficient to drive a 600 ohm external load. Scaled range shall be as shown on the Instrument Device Schedule or as determined by the Contractor. Power supply for the instrument loop completed by the interface shall originate from the main control panel. The Contractor shall shunt the interface connections, closing the loop, with an appropriately sized resistor as necessary to allow checkout during panel fabrication and Site testing.

.5 Analogue Output Points. The interface shall be an isolated 4 to 20 ma DC electronic load having an impedance not exceeding 600 ohms. Power supply for the instrument loop completed by the interface shall originate from the area PLC panel.

11.12 Interlocks

.1 The following interlocks shall be provided within each DAF control panel.

.1 EMERGENCY STOP shall trip all DAF clarifier equipment.

.2 Saturator low pressure (after adjustable time delay) shall trip the recycle pump.

.3 Saturator pressure retention valve interlocked with start/stop contact of recycle pump.

.4 Recycle pump failure (pump in RUNNING mode but zero saturator influent flow after adjustable time delay) shall close saturator pressure retention valve.

.5 Float scraper interlocked with stop contact of recycle pump.

.6 Float trough spray wash header solenoid valve interlock with stop contact of the reciprocating scraper.

.2 Each float scraper and float trough spray wash header shall be capable of operating independently of each other and without running the recycle pump.

11.13 Sequence of Operation

.1 The DAF clarifier equipment operation shall be designed to be manual with the exception of several semi-automatic shutdown sequences listed. The starting and stopping of the DAF clarifier equipment shall be in the following order:

.2 Initial Conditions

.1 At the recycle pumps local control panel, select REMOTE control for desired recycle pump for feeding saturator.

.2 At the DAF compressor package local control panel, select REMOTE control.

.3 At the float scraper local control panel(s), select REMOTE control.

.4 Along recycle piping, verify proper position of all necessary process valves.

.3 System Start

.1 The following sequences shall be performed at the DAF control screen on the plant SCADA (by others). The control resident within the DAF PLC shall have provision for the commands and status' required by the SCADA.

.1 Set the selector switch to correspond to the number of DAF basins to be supplied by both saturators.

.2 START compressor.

.3 Verify saturator pressure is at the air pressure control setpoint.

.4 Select which pump of three recycle pumps to supply recycle flow to saturator by selector switch.

.5 START selected recycle pump. After a preset time period, the saturator pressure retention valve will open automatically.

.6 Set float scraper repeat cycle time and speed. START reciprocating scraper(s).

.7 Set spray wash repeat cycle time. START float trough spray wash header(s).

.4 Normal System Stop

.1 The following sequence shall be performed at the DAF control screen on the plant SCADA (by others). This control shall be programmed into the DAF PLC which will have provision for the commands and status' required by the SCADA.

.1 STOP recycle pump. [If only one (1) of two (2) DAF basins in operation is desired to be taken offline, recycle shutoff valves at that basin are to be manually closed while recycle pump remains in RUNNING mode].

.2 This will initiate an automatic closure of the saturator pressure retention valve.

.3 After a preset number of cycles, float scraper(s) will automatically shut down. [If only one (1) of two (2) basins in operation is taken offline, press STOP for that basin's float scraper after several cycles to clear basin float].

.4 Upon shutdown of float scraper(s), the associated float trough spray wash header(s) will automatically shut down after a preset time period.

.5 Reset selector switch to correspond to the number of on-line DAF basins.

.6 STOP compressor only if the entire train [four (4) basins] is to be taken offline.

.5 Emergency System Stop

.1 The DAF control emergency stop push button shall stop all DAF clarifier equipment for a train at any time.

12. EQUIPMENT INSTALLATION

.1 The equipment installation will be undertaken by an Installer selected through the public tendering process. The Installer will be responsible for all aspects of the equipment installation. However, the Contractor shall visit the Site during construction as least as frequently as defined in Clause 14 of this Section to oversee the installation and to ensure all requirements are being achieved.

13. PROCESS PERFORMANCE GUARANTEE AND TESTING

13.1 Guarantees

.1 The performance of the DAF process shall be guaranteed to produce a DAF effluent which meets the performance and design requirements stipulated herein at the design flow rate while the plant is operating within the specified raw water parameters. The process guarantee shall include the DAF system guarantees on equipment, materials, and workmanship. Two (2) basins served by a common saturator vessel shall be tested in order to operate the DAF clarifier equipment at design capacity.

.2 Float Scrapers

.1 Manufacturer's Experience

.1 The Manufacturer shall demonstrate experience as per Part B of this Bid Opportunity.

.2 Scraper Shop Performance Testing

.1 If the float scraper does not satisfy the DAF Equipment Manufacturer's experience requirement, the float scraper shall undergo a full-scale Shop test. One (1) full-scale version of the proposed float scraper design shall be fabricated and utilized in a test tank of the length and width indicated in the Contract Documents for a performance and mechanical integrity test lasting fourteen (14) consecutive days. The Contract Administrator shall witness the Shop test. All costs for test witnessing shall be paid by the Contractor. Fabrication of further scrapers for this Contract will not be authorized until the performance is deemed acceptable. If the performance of the proposed design is deemed unsatisfactory during the test, the Contract Administrator shall have the right to disqualify the design and require that the design conform to the DAF Equipment Manufacturer's experience requirement.

.3 Overall System Performance Testing

.1 The overall system performance test shall be conducted by competent, authorized representatives of the DAF Equipment Manufacturer who are familiar with operation of the equipment supplied and who have previous satisfactory experience in conducting tests of the type specified. The Installation contractor, Contractor, and the City's operating personnel will assist the DAF Equipment Manufacturer's Representative in the performance test. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. At a minimum, the DAF Equipment Manufacturer's field representatives shall be made available as indicated in the inspection, testing, and training paragraph. Representatives of the Contract Administrator will observe the tests and collect a copy of the recorded data and laboratory data. The information collected will be used as a basis for determining acceptability of the DAF Equipment Manufacturer's results. In case of conflict, interpretations and calculations made by the Contract Administrator will govern.

.1 At least two (2) weeks prior to the proposed testing date, the Installer shall notify the Contract Administrator of the testing date and shall submit a report from the DAF Equipment detailing the proposed performance testing and analyses. Testing shall begin on Monday. The Contract Administrator's initial observation of tests will be at the City's expense. All costs of subsequent visits by the Contract Administrator to witness or observe additional tests necessary because of failure of the initial tests or inability to conduct the initial tests shall be paid for by the Contractor.

.2 If a fourteen (14) day performance test is completed but the specified DAF effluent criteria are not met, the test shall be deemed to "Fail", and the Contractor shall be responsible for all costs incurred for remedial action. Upon the

completion of the remedial Work, the performance test shall be repeated, as necessary until a successful result is achieved.

13.2 Test Procedures

.1 Two (2) field performance tests shall be conducted using the DAF systems under the service and design conditions specified to demonstrate the DAF systems' ability to consistently perform at the performance and design requirements specified in Part B of this Bid Opportunity. The performance tests shall be conducted for at least fifteen (15) consecutive days and shall commence after the installation is complete and as soon as all system components are operating properly as determined by the DAF Equipment Manufacturer's Representative. The Installer, City, and the DAF Equipment Manufacturer shall mutually agree in writing when the DAF clarification system is ready for the performance test.

.2 Each performance test shall last twenty-four (24) hours a day for at least fifteen (15) consecutive days. One (1) performance test shall be conducted during each of the following periods:

.1 Immediately after start-up, upon the mutual agreement between the Installer, City, Contract Administrator, and DAF Equipment Manufacturer that the system is ready for the performance test.

.2 During frequent algae blooms that occur during the months of August through September following initial start-up.

.3 During the fifteen day test period, the basin being tested shall be operated at 3 discrete testing conditions, to mimic the conditions listed in Part B of this Bid Opportunity, as follows:

.1 Operation of the basin at 100% of its design capacity, with a saturator pressure of 590 kPa(g), and an air loading of 10% (5 days);

.2 Operation of the basin at 75% of its design capacity, with a saturator pressure of 590 kPa(g), and an air loading of 10% (5 days);

.3 Operation of the basin at 50% of its design capacity, with a saturator pressure of 590 kPa(g), and an air loading of 10% (5 days);

.4 Hourly samples shall be taken on both the raw water and DAF effluent. If samples are not analyzed immediately, they shall be preserved prior to analysis. The raw water sample shall be taken at the sample sink in the operator's laboratory. The DAF effluent samples shall be withdrawn through the access hatches before the DAF effluent weir. Each sample shall be tested for turbidity. Every fourth sample shall be tested for algae. Laboratory costs of testing shall be paid by the Contractor.

.5 During performance testing, the DAF 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 DAF clarifier equipment.

.6 The data to be determined in each test shall include, but not be limited to:

.1 DAF basin influent flow rate.

.2 Water temperature.

.3 Recycle flow rate.

.4 Saturator vessel pressure.

.5 Percent of open recycle injection header nozzle area.

.6 Float scraper speed.

.7 Chemical dosage.

.8 Total DAF System Power Consumption.

.7 The performance requirements of the DAF 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 fifteen day test period is required to achieve this objective, then the test will be extended beyond the fifteen day period until the limit is achieved. It is understood that the performance requirements include the Contract Guarantees on equipment, materials, and workmanship.

.8 Should the City be unable to produce a DAF effluent quality within the limits previously set forth during a test period due to any malfunction of the DAF system, equipment, or plant process, or if the raw water characteristics exceed the limits previously set forth, the five (5) day test period shall begin again. The procedures shall be continued until such time as five (5) consecutive calendar days have been accumulated.

.9 Costs associated with repeated performance testing due to items outside the Installer's and Contractor's control shall be borne by the City.

13.3 Modifications

.1 If, after operating under the specified service conditions, design loading conditions, and in accordance with the DAF Equipment Manufacturer's Representative's instructions, the results of the field performance test indicate that the effluent quality is not in compliance with the performance and design requirements stipulated herein, the DAF Equipment Manufacturer shall undertake all engineering Work and analysis necessary at the Contractor's expense to determine the cause of such non-compliance. If the DAF Equipment Manufacturer finds, and the Installer, City, and Contract Administrator concur, that the cause of such non-compliance is the failure of the Installer or City to meet the conditions of the warranties, the Contractor shall be reimbursed the cost and expenses incurred in identifying the problem. However, if the cause of such non-compliance is faulty

equipment or negligence on the part of the DAF Equipment Manufacturer, the Contractor will be required to make the necessary modifications at no additional cost to the City.

.2 If modifications to the DAF system supplied by the DAF Equipment Manufacturer are necessary to achieve compliance with the process guarantee, the DAF Equipment Manufacturer shall make whatever modifications it deems necessary, as agreed upon by the City and Contract Administrator, and shall repeat the performance test. The DAF Equipment Manufacturer may require repeated tests and modifications as agreed upon by the City and Contract Administrator until the performance requirements are achieved. The Contractor shall be responsible for the cost of all such modifications, engineering and construction of such modifications, retesting, laboratory analysis, and other related costs.

14. INSPECTION, TESTING, AND TRAINING

.1 The Contractor shall supply the services of a competent DAF Equipment Manufacturer's Representative with at least five (5) years of relevant experience who has complete knowledge of proper O&M of the equipment and DAF system for a period of not less than sixty (60) days in six (6) separate trips (excluding travel time). Equipment installation inspection, testing, and instruction service time will be divided according to the following:

Mechanical equipment installation assistance (2 trips)	18 days (total)
Plant operating personnel training and plant start-up assistance (1 trip)	21 days (total)
Start-up assistance	18 days
Operations and maintenance training only	3 days
Performance testing (3 trips)	21 days (total)

.2 Training shall be coordinated by the Contract Administrator.

.3 Additional days and trips required for mechanical equipment installation assistance shall be provided at cost to the Contractor. Additional days required for plant operating personnel training and plant start-up assistance shall be paid by the City to the Contractor on a per diem basis. Additional days and trips required for performance testing shall be provided a no additional cost to the City, unless the raw water is outside the specified raw water parameters.

.4 A mechanical performance test shall be performed by the Installer after the plant is in service under supervision of the Contract Administrator and the DAF Equipment Manufacturer's Representative. The Contractor shall supply all labour, materials, and equipment required for such tests and shall correct any deficiencies noted by repairing or replacing the defective equipment and completing the testing.

.5 Each DAF basin shall be examined for even distribution of DAF recycle and to ensure that the recycle injection header nozzle is operating properly. Each recycle pump, compressor, saturator, and float scraper shall undergo separate testing, including normal start, normal stop, and emergency stop cycles according to their designed functions within each cycle.

The testing of each DAF basin should include the testing of all valves, including manual, electric, and pneumatic valves for open-close service and DAF system control.

.6 Any malfunctions appearing during the tests shall be corrected and additional testing performed, as directed by the Contract Administrator and DAF Equipment Manufacturer's Representative to assure that the defective or maladjusted equipment will perform satisfactorily after adjustment.

.7 The DAF Equipment Manufacturer shall prepare a formal test report, including all measured flows, influent and effluent turbidity, influent and effluent algae counts, and other recorded data and observations as specified. Six (6) copies of the report shall be submitted to the Contract Administrator within thirty (30) days after completion of the specified tests.

.8 Provide completed Form T1 – Certificated of Satisfactory Training in accordance with **Section 01650.**

15. DRAWINGS AND DATA

.1 Complete fabrication, assembly, foundation, schematic and wiring diagrams, and installation Drawings, together with detailed Specifications and data covering materials used, power drive assemblies, parts, devices, and other accessories forming a part of the equipment supplied, shall be submitted in accordance with the **Section 01300** - Submittals. Drawings shall indicate all dimensions and structural member sizes and shall bear the seal of a registered Professional Engineer. The data and Specifications for each unit shall include, but shall not be limited to, the following:

.1 Float Scraper

.1 Manufacturer.

.2 Structural Drawings.

.3 Size, make, and type of electric motor.

.4 Electrical control equipment.

.5 Electrical control schematic.

.6 Type, Specifications, details, input and output speeds, exact gear ratios, and service factor [twenty-four (24) hour continuous service] or gear reducers.

.7 Wiring diagram and electrical schematic.

.8 Shafts.

.9 Bearings.

.10 Float Beach.

.11 Structural Drawings.

.12 Dimensions.

.13 Angle of incline.

.2 Saturator Vessel

.1 Manufacturer.

.2 Capacity.

.3 Pressure rating.

.4 Data on Shop painting.

.5 Structural Drawings.

.6 Size and location of access hatches, packing removal ports, and flanged and threaded connections.

.7 Packing support grating.

.8 Dimensions.

.9 Valves.

.10 Verification of ASME code stamp.

.3 False Floor or Perforated Pipe Laterals

.1 Hydraulic Calculations sealed by a Professional Engineer registered in the province of Manitoba to demonstrate the ability of the systems to meet the specified hydraulic constraints.

.4 Recycle Injection Headers

.1 Manufacturer.

.2 Type, size and spacing of nozzles.

.3 Piping and support data.

.5 DAF Compressor Package

.1 Overall dimensions.

.2 Number, size, and location of mounting holes.

.3 Weight.

.4 Air inlet filter details.

.5 Oil removal filter details, including initial pressure drop and efficiency for each.

.6 Accessory details.

.7 After cooler details, including approach temperature.

.8 Enclosure details, including estimated noise level at 1 m.

.9 Compressed air piping arrangement Drawings.

.10 Piping schematic.

.11 Control equipment.

.12 Sequence of operation.

.13 Data on Shop painting.

.6 Compressor

.1 Manufacturer.

.2 Type and model.

.3 Rotative speed.

.4 Size of discharge nozzle.

.5 Dimensions.

.6 Weight, including motor.

.7 Compete performance curves at variable discharge pressures showing capacity versus head and bhp.

.8 Bearing data.

.7 Air Receiver

.1 Capacity.

.2 Pressure rating.

.3 Dimensions.

.4 Connection sizes and locations.

.5 Verification of ASME Code stamp.

.8 Spray Wash Headers

.1 Type, size, spacing, and location of nozzles.

.2 Piping and supports data.

.3 Automatic spray wash control valve.

.9 Motors

.1 Name of Manufacturer.

.2 Type and model.

.3 Type of bearings and lubrication.

.4 Rated size of motor, hp and service factor.

.5 Temperature rise and insulation rating.

.6 Full load rotative speed.

.7 Net weight.

.8 Efficiency at full, $^{3}/_{4}$, and $^{1}/_{2}$ load.

.9 Full load current.

.10 Locked rotor current.

.11 Space heater wattage.

.12 Motor temperature switch data.

.10 Control Panels

.1 Dimensions layout and mounting details.

.2 Materials of construction.

.3 Wiring diagrams and control schematic.

.11 VFD Unit

.1 Type and model.

.2 Name of Manufacturer.

.3 Operating speed range, rpm.

.4 Rated bhp at max speed.

.5 Efficiency at max speed, percent.

.6 Max heat output, kJ/hour.

.7 Speed at max heat output, rpm.

.8 Net weight.

.9 Wiring diagrams.

.10 Data on variable frequency drives as specified in the variable frequency drives Section.

.2 Electrical connection diagrams and schematics identifying all items shall be provided for each device or piece of equipment requiring electrical power or control. A pneumatic piping schematic identifying each item of equipment and each accessory item requiring an air supply shall be furnished.

END OF SECTION

FACTORY APPLIED MAINTENANCE AND CORROSION PROTECTION COATINGS

1. GENERAL

1.1 Work Included

.1 Supply and application of all factory applied prime coats or factory applied finish coats.

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 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 50 micron blast profile.

2.2 Prime Coating

.1 Prime coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 Coat ferrous surfaces with inorganic zinc primer, containing a minimum of 50% solids by volume, applied to a minimum dry film thickness of 75 microns.

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 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.

3.2 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.

3.3 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

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

.1 Complete an operational electrical package for each process unit as required. A process unit is a Supplier package or individual process equipment as specified in other Sections.

.2 Identify and submit to the Contract Administrator power requirements for each process unit. The Contractor shall identify the size of an over current protection device (fuses and/or breaker) and feeder size for each process unit supplied.

1.2 Quality Assurances

.1 Codes, Rules, Permits, and Fees:

.1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.

.2 Comply with all rules of local Electrical Code and the applicable building codes.

.3 Quality of Work specified shall not be reduced by the foregoing requirements.

.4 All components shall be Canadian Standards Association (CSA) approved.

.2 Standard of Workmanship:

.1 Execute all Work in a competent manner and to present an acceptable appearance when completed.

1.3 Submittals

.1 Submit samples as required where specified in Division 16 and 17.

.2 Refer to **Section 01300 -** Submittals for general requirements for submittals.

.3 Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed.

Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.

.4 Manufacture of products shall conform to revised Shop Drawings.

1.4 Operation and Maintenance Manuals

.1 Refer to **Section 01730 –** Operation and Maintenance Manuals for general requirements for Operation and Maintenance (O&M) Manuals.

1.5 Product Handling

.1 Use all means necessary to protect the Products of this Division until **Form 100** is completed.

.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.

2. PRODUCTS

2.1 Selected Products and Equivalents

.1 Products and materials provided shall be new and free from all defects. Defective Products or materials will be rejected regardless of previous inspections. The Contractor shall be responsible to remove and replace defective Products at their expense, and shall be responsible for any resulting delays and associated expenses, which result from defective Products being rejected. Related materials shall be of the same manufacturer.

2.2 Quality of Products

.1 All Products provided shall be Underwriters Laboratories Inc. (UL) or CSA approved, or approved by local authority having jurisdiction in the area where the equipment is going to be installed.

.2 If Products specified are not approved as specified above, 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.

2.3 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, maintain uniformity of manufacture for similar Products throughout the Work.

3. EXECUTION

3.1 Equipment Identification

.1 3 mm thick plastic lamacoid name plates, white background, mechanically attached with self tapping screws, 6 mm high black lettering, to be attached to the front face of the following equipment:

.1 Starters, contactors, and disconnects (designation, voltage, load controlled).

.2 Terminal cabinets and pull boxes (system, voltage).

END OF SECTION

SCOPE OF SUPPLY

1. GENERAL

.1 Refer to **Sections 11000** through **11490**.

.2 This Section describes the Electrical Division scope of supply for the Dissolved Air Flotation (DAF) and Flocculation Equipment electrical package.

.3 The Contractor shall furnish all necessary components to provide a complete and fully functioning DAF and Flocculation Equipment electrical package.

.4 Contractor to provided recommendations for the supply of starters for large motors (over 22 kW).

1.2 Process Area Environment

.1 This paragraph describes process area environment for various components of the DAF and Flocculation Equipment.

.1 The DAF and Flocculation Equipment electrical components will be installed in the water treatment plant (WTP) main process area, which is considered a wet and corrosive location.

.2 Local Control Panel for the DAF and Flocculation Equipment and electrical distribution panels will be installed in the WTP main process area, which is considered a wet and corrosive location.

1.3 Scope of Supply

.1 For the DAF and Flocculation Equipment electrical system the Contractor shall supply the following:

.1 All motor starters and control devices as required to supply a complete electrical system.

.2 All variable frequency drives (VFD) and control devices as required to supply a complete electrical system.

.3 All wires and cables as required to supply complete electrical system

.4 All junction boxes and pull boxes as required to supply complete electrical system.

.5 All wire and box connectors as required to supply a complete electrical system.

.6 All other components as required to supply complete electrical system.

2. PRODUCTS - NOT USED

3. EXECUTION - NOT USED

END OF SECTION

WIRES AND CABLES 0 - 1000 V

1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation of each process unit as required. A process unit is a Supplier package or individual process equipment as specified in other Sections.

1.2 References, Codes, and Standards

.1 Canadian Standards Association (CSA) C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 CSA Standard C22.2 No. 131 for Teck cables.

.3 Install and rate power cables in accordance with the local Electrical Code requirements.

2. PRODUCTS

2.1 Wires

.1 Conductors: stranded for ten (10) American Wire Gauge (AWG) and larger.

.2 Copper conductors: size as required by the applicable codes, with 600 V insulation of chemically cross-linked thermosetting polyethylene (XLPE) material rated RW90.

2.2 Teck Cable

.1 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper, size as required by the applicable codes.

.2 Insulation:

.1 Type: ethylene propylene (EP).

.2 Chemically XLPE rated type RW90, 600 V.

.3 Inner jacket: polyvinyl chloride (PVC) material.

.4 Armour: interlocking aluminum.

.5 Overall covering: PVC material.

.6 Fastenings:

.1 One (1) hole aluminum straps to secure surface cables 50 mm and smaller. Two (2) hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two (2) or more cables.

.3 6 mm diameter threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight in non classified areas, explosion-proof in classified areas, as approved for TECK cable.

2.3 Control Cables

.1 Type low voltage thermoplastic (LVT): Two (2) soft annealed copper conductors, sized as required by the applicable codes, with thermoplastic insulation, outer covering of thermoplastic jacket.

.2 Low energy 300 V control cable: Stranded annealed copper conductors sized as required by the applicable codes, with PVC insulation type over each conductor and overall covering of PVC jackets and interlocked aluminum armour.

.3 600 V type: Stranded annealed copper conductors, sizes as required by the applicable codes with PVC insulation type, XLPE type R90 (x-link) over each conductor and overall covering with sheath of aluminum interlocked armour and jacket over sheath of PVC.

3. EXECUTION

3.1 Installation of Teck Cable 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Terminate cables in accordance with **Section 16151** - Wire and Box Connectors - 0 -1000 V.

3.2 Installation of Control Cables

.1 Install control cables in conduit or use Teck cables.

.2 Ground control cable shield at one end only.

3.3 Workmanship

.1 Before pulling wire, ensure conduit is dry and clean. If moisture is present, thoroughly dry out conduits; vacuum if necessary. To facilitate pulling, recognized specially manufactured wire pulling lubricants may be used. Do not use grease. Employ suitable techniques to prevent damage to wire when ambient temperature is below the minimum permitted for each insulation type. Pull wires only into complete runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the local Electrical Code. Submit data sheet with values measured.

.3 Provide sizes of conductors as required by the applicable codes.

.4 Exercise care in stripping insulation from wire. Do not nick conductors.

3.4 Identification, Coding and Balancing

.1 Colour code all feeders at all terminations, at all points where taps are made, and at all panelboards, switchboards, motor control centres, etc. Use two (2) wraps of 3M No. 471 plastic film tape 48 mm wide.

.2 For direct current wiring use red for positive and black for negative.

3.5 Testing

.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 the cable manufacturer.

.2 All wire test results shall be properly tabulated, signed, dated, and submitted to the Contract Administrator.

END OF SECTION

JUNCTION BOXES AND PULL BOXES

1. GENERAL

1.1 Work Included

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment that is part of the equipment scope of supply.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

.1 Type 316 L stainless steel or cast aluminum, National Electrical Manufacturer's Association (NEMA) 4X suitable for outdoor locations.

2.2 Junction Boxes and Pull Boxes for corrosive process areas

.1 Materials:

.1 Stainless steel or cast aluminum, suitable for corrosive areas.

3. EXECUTION

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes required for the installation.

.2 Identify with system name and circuit designation as applicable.

.3 Size in accordance with the local Electrical Code, as a minimum.

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 wiring installation on each process unit as required. A process unit is a Supplier package or individual process equipment as specified in other Sections.

1.2 Special Codes

.1 Install and rate power cables in accordance with the applicable Electrical Code requirements, or in accordance with Insulated Power Cable Engineers Association (IPCEA) requirements where permissible.

1.3 References

.1 Canadian Standards Association (CSA) C22.2 No. 65 Wire Connectors.

.2 Electrical and Electronic Manufacturers of Canada (EEMAC) 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere 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 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded copper conductors.

.2 Clamp for stranded copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper conductors.

.3 Clamps or connectors for armoured cable, aluminum sheathed cable, 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 No. 10 American wire gauge (AWG) and smaller motor connections. Tape with rubber and scotch tape. Lugs to accept ten (10) - 32 x 3/8" machine bolts.

.3 Terminate conductors No. 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 the 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 the Manufacturer.

.4 Do not Install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 Scope of Work

.1 This Specification describes the requirements for the supply of motor starters for three (3) phase, squirrel cage induction motors as required by various process equipment specified in this Specification.

1.2 References

.1 National Electrical Manufacturer's Association (NEMA) Contactors and Motor-starters.

1.3 Starter Requirements

.1 Provide motor starters for all single-phase and three (3) phase motors as required.

.2 Provide interlocking between starters where required.

.3 All starter accessories such as pilot lights, Computer-Off-Hand (COH), Start-Stop, etc. whether integrally or remote mounted shall be heavy duty oil tight, unless otherwise specified. Each COH switch shall have a voltage free contact terminated in terminals indicating Computer and NON-Computer position of the switch. Computer status for each COH switch shall be wired to a digital input on the programmable logic controller (PLC).

1.4 Shop Drawings and Product Data

.1 Submit Shop Drawings in accordance with **Section 16010 -** Electrical General Requirements and **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.

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance (O&M) data for motor starters for incorporation into manual specified in **Section 16010 -** Electrical General Requirements and **Section 01730 –** Operation and Maintenance Manuals**.**

.2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Manufacturer recommendation. Include maintenance materials, special tools, and spare parts.

.2 Provide listed spare parts for each different size and type of starter:

.1 Three (3) contacts, stationary.

.2 Three (3) contacts, movable.

.3 One (1) contact, auxiliary.

.4 One (1) control transformer(s).

.5 One (1) operating coil.

.6 Two (2) fuses.

.7 10% indicating lamp bulbs used.

2. PRODUCTS

2.1 Materials

.1 Starters to NEMA Standards.

2.2 Enclosure

.1 All individually mounted motor starters shall be enclosed in a general purpose sheet steel enclosure unless in wet areas where they shall be watertight Electrical and Electronic Manufacturers of Canada (EEMAC) 4.

2.3 Manual Motor Starters

.1 Manual motor starters shall be of size, type, rating, and enclosure type as required by local applicable codes, with components as follows:

.1 Switching mechanism, quick make and break.

.2 Overload heaters, manual reset, and trip indicating handle.

.3 Rated volts and poles to suit application.

.2 Accessories:

.1 Indicating lights: Heavy duty L.E.D. type and colour as indicated.

.2 Locking tab to permit padlocking in "ON" or "OFF" position.

2.4 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Combination magnetic starters shall be of size, type, rating, and enclosure type as required by local applicable codes 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 shall include fused disconnect switch, or motor circuit interrupter, or circuit breaker with operating lever on outside of enclosure to control the disconnect switch, or the motor circuit interrupter or the circuit breaker, and provision for:

.1 Locking in "OFF" position with up to three (3) padlocks.

.2 Independent locking of enclosure door.

.3 Provision for preventing switching to "ON" position while enclosure door open.

.3 Accessories:

.1 Pushbuttons, selector switches: heavy duty labelled to identify control function.

.2 Indicating lights: Heavy duty L.E.D. type 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, one (1)-N/O and one (1)-N/C spare auxiliary contacts unless otherwise indicated.

2.5 Full Voltage Reversing (FVR) Magnetic Starters

.1 FVR magnetic starters shall be of size, type, rating, and enclosure type as required by local applicable codes with components as follows:

.1 Two (2) to three (3) pole magnetic contactors mounted on common base.

.2 Mechanical and electrical interlocks to prevent both contactors from operating at same time.

.3 Three (3) overload relays with heater elements, manual reset.

.2 Accessories:

.1 Pushbuttons selector switches: Heavy duty labelled to identify control function.

.2 Indicating lights: Heavy duty L.E.D. type, 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, one (1)-N/O and one (1)-N/C spare auxiliary contacts per contactor unless otherwise indicated.

2.6 Equipment Identification

.1 Provide equipment identification in accordance with **Section 16010 -** Electrical General Requirements.

.2 Manual starter designation label, white plate, black letters, size one (1).

.3 Magnetic starter designation label, white plate, black letters.

2.7 Approved Manufacturers

.1 Approved motor starter manufacturers are: Schneider Electric, Cutler-Hammer, Square D, and Allen Bradley.

.2 Multilin motor protector relays are preferred for large motor protection.

3. EXECUTION

3.1 Installation

.1 Install starters.

.2 Ensure correct fuses and overload devices elements installed.

3.2 Starter Verification

.1 Field check motor starters supplied prior to commissioning 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 Overload Relays

.1 For starters provided, select overload relays 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 loads, provide special overload relays to suit the start-up condition. Provide Manufacturers' curves and data sheets for the driven equipment where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Operate switches, contactors to verify correct function.

.2 Perform starting and stopping sequences of contactors and relays.

.3 Check that sequence controls, interlocking with other separate related starters, equipment, and control devices operate as indicated.

END OF SECTION

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Standards

.1 All variable frequency drives (VFD's) supplied under this Contract shall meet or exceeds the following Specifications.

.2 Provide a complete inventory of spare cooling fans, and fuses, for each VFD supplied.

.3 The adjustable frequency controller shall be designed to operate standard squirrel cage induction motor with a 1.15 S.F. or definite purpose motors meeting National Electrical Manufacturer's Association (NEMA) MG1 Part 31.

.4 Harmonic loading shall not exceed a motor service factor of 1.0.

.5 Products shall comply with Institute of Electrical and Electronic Engineers (IEEE) Standard 519.

.6 VFD unit shall be Underwriters Laboratories Inc. (UL) listed and Canadian Standard Association (CSA) certified.

.7 VFD unit shall comply with applicable requirements of the latest standards of CSA, American National Standards Institute (ANSI), IEEE and the Canadian Electrical Code (CEC).

1.2 Tests

.1 Factory testing

.1 VFD units are to be factory tested 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 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) to the Contract Administrator, prior to acceptance of the equipment.

.2 Field testing

.1 The VFD Manufacturer's Representative shall provide on-site start-up, fine-tuning, commissioning, operator training and instruction.

.2 The VFD Manufacturer's Representative shall provide Site functionality test reports indicating loading/current levels during testing as well as control point proving results.

.3 The VFD Manufacturer's Representative shall ensure shaft to ground voltages do not exceed 1.5 V at any speed or load requirement.

.4 Allow for all costs and labour for as many trips as necessary to complete requirements.

.5 It is the intent of this Specification to provide a VFD installation that does not adversely affect the electrical system.

The VFD Manufacturer's Representative shall evaluate the predicted effect of the VFD installation on electrical system and advise the Contract Administrator of these effects. Further information about the electrical distribution on-site will be provided upon request.

.3 Provide certified copies of all production test results required by CSA and NEMA.

2. PRODUCTS

2.1 Variable Frequency Drives

.1 VFD as supplied by one of the following acceptable Manufacturers:

.1 ABB ACS 800 series.

.2 Mitsubishi.

.3 Toshiba.

.2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.

.3 The VFD shall employ 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 The drive shall be 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. Drive output shall be sized for a 1.0 motor service factor. The VFD shall have a current rating at least 10% in excess of the motor full load amp rating. Overload service factors of 110% for thirty (30) minutes and 135% for one (1) minute must be provided to ensure adequate safety margins. VFD selection shall be based on load current at constant torque ratings. Do not size VFD's based on variable torque maximums.

.5 The VFD shall have a fixed bridge type converter (PWM) with a minimum of 98% input displacement power factor over a 10 to 100% speed range. The efficiency shall be a minimum of 97% for all inverters when operated at full speed and load.

.6 Input voltage shall be as indicated on motor schedules and Drawings (line voltage variation ±10%). Based on 347/600 volt systems (Not 575 V). Line frequency variation

±5%. Output voltage shall vary with motor speed to nominal motor voltage. Speed stability shall be ±1%. Drive shall match torque characteristic of load.

.7 Input frequency setting signal will be 4 to 20 mA. Output speed monitoring signal shall be 4 to 20 mA.

.8 Enclosure:

.1 Drive shall be installed in motor control centres or with individual CSA one (1) enclosure, drip proof or NEMA 12. Filters to be provided for any forced air cooled enclosures as required by the Manufacturer. VFD(s) shall be suitable for mounting in a typical building electrical room and shall be able to operate under these conditions with no special cleaning requirements. VFD cabinets shall be mounted in such a way that there is adequate room for ventilation and no build up of heat. The minimum clearance in front of VFD's is 1 m.

.9 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 start-up.

.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, and must

indicate as to the requirement or non-requirement of longlead filter package components in their submittals.

.14 Maximum acceptable noise level is 80dBA at 1m.

.10 Operation features:

.1 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. Remote keypads, completely duplicating functions of integral keypads, shall also be provided for all VFD(s) located inside a fan plenum. The remote keypads in these cases shall be located adjacent to the door entering the plenum.

.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 Computer/Off/Hand selector switch. Keypad C/O/H 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 4-20 mA.

.19 Ethernet data communication gateway.

.1 A data communication gateway shall be provided for the connection to the Ethernet Plant Control and Monitoring System. The data communication protocol shall be Modbus/transmission control protocol (TCP).

.11 Environmental Capabilities: The drive shall 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 0 to 1250 m.

.12 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.

.13 Cooling System:

.1 Contractor to provide adequate proven cooling devices for VFD equipment.

.2 Contractor to ensure any enclosure utilized will not allow a build up of heat. This can be accomplished by use of fans and/or sufficient guarded, filtered openings.

.14 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 ten (10) cycles. Based on 347/600 volt systems.

.3 Line voltage sags down to 85% of rated voltage of up to one (1) second duration.

.2 Control wiring shall be TEW 105° C rise.

.3 Terminal blocks in separate control enclosures for remote interface shall be Weidmueller SAK6N or approved equivalent.

.4 Provide wire markers at both ends of all control wires, Electrovert Type Z or approved equivalent.

3. EXECUTION

3.1 Operations Manual Information

.1 The Contractor shall provide the VFD Manufacturer 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 master control panel (MCP) or fuse and overload.

.2 Installation

.1 Identify mounting requirements including concrete pads for all floor mounted equipment.

.2 Contractor shall make provisions for the wiring of 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.

.3 Contractor shall ensure that all safety interlocks, control and stop commands shut down the drive as per Manufactures 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.

.4 VFD and motor isolation switch shall be labelled with proper shutdown procedures as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch".

"* Record all faults before resetting".

.5 Motor supply cables/conductors shall be run in conduits separate from supply feeders to line side of VFD. No conductors (supply or motor feeders) are to be taped or otherwise bundled within the conduits.

.3 Field Quality Control

.1 Contractor shall be responsible for complete commissioning of each variable speed drive to satisfaction of the Contract Administrator and the City. Contractor shall allow for factory representative to completely calibrate all drive circuits after installation on-site.

.2 Contractor shall be responsible to bring Factory representative back to reset, repair, and re-commission the VFD during the warranty period if problems arise with the normal operation of the VFD. This includes prevention of any motor shaft voltages exceeding 1.5 volts when referenced to ground.

.4 Software

.1 Provide VFD programming/troubleshooting software to City.

.2 Provide VFD Parameter list "as programmed during commissioning" for each VFD.

.5 VFD Shop Drawings.

.1 The Contractor shall indicate the level of local support detailing response time if a piece of equipment should happen to fail or malfunction. Details are to include estimated replacement part delivery times, as well as nearest parts depot location and a contact name and phone number.

.2 The Shop Drawings for each type/size of VFD 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.

.3 Provide labels/lamacoids on each VFD, isolation switch as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch".

"* Record all faults before re-setting".

.4 All Drawings, manuals, parameter settings, and test reports are to be included with the "Electrical Maintenance Manual". This manual shall be issued in both Hard Copy and Electronic format.

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 supplied 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 Section 17 for example, pressure, flow, float, solenoid valves, panels, pneumatic electric switches, transducers, etc. A process unit is a supplier package or individual process equipment as specified in other Sections. Some or all of the preceding items are interconnected under Part 3 of this Specification.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from normally-open (NO) to normally-closed (NC), electrically held with sliding barrier to permit access to contacts only or coil only, three (3) to four (4) poles. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.

.2 Sealed contact type: electrically held with three (3) to four (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 three (3) to four (4) poles, convertible from NO to NC by changing wiring connections. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.

.4 Fixed contact type: heavy duty with three (3) to four (4) poles. Coil rating: 120 V. Contact rating: 120 V, minimum 3 A.

2.2 Relay Accessories

.1 Standard contact cartridges: NO - convertible to NC in field.

2.3 Sealed Contact Oil tight Limit Switches

.1 Lever type switches: roller operated, double pole, double throw. Contact rating: Electrical and Electronic Manufacturer's Association of Canada (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: Canadian Standards Association (CSA) Type four (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 plus 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: Three (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 one (1), surface mounting

2.7 Pushbuttons

.1 Heavy duty, Operator recessed, flush, or mushroom type, as required. Black, with one (1)-NO and one (1)-NC contacts rated as required. Stop pushbuttons coloured red, provision for padlocking in depressed position. Design standard Allen Bradley 800 H series.

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, minimum 3 A, ac. Design standard Allen Bradley 800 H series.

2.9 Indicating Lights

.1 Heavy duty, full voltage, push-to-test, lens colour: as required, L.E.D. type lamps, labels as required. Design standard Allen Bradley 800 H series.

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 (1) copy of test results.

END OF SECTION

1. GENERAL

1.1 Requirements of Work

.1 Supply a complete and fully documented instrumentation and control (I&C) system as specified herein. The I&C system will form a subsystem of the overall plant control system.

.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 power supplies.

.6 Instrument cabling and associated conduit and/or fasteners where the instrument is connected to a control panel or other instrument located within the same equipment package skid.

.3 Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.

.4 Documentation provided by the Contractor shall include as a minimum:

.1 Equipment descriptive data.

.2 Equipment installation instructions, service manuals, operation and maintenance (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, and other information necessary for field installation of the equipment or system.

.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 Input and Output (I/O) lists for digital or programmable systems.

.7 For the programmable logic controller (PLC) based control system, the Contractor shall provide detailed documentation of the system hardware and software. Minimum software documentation shall include a detailed operating description, flow charts that

describe the functionality of the PLC program, a memory map, and the PLC program documentation. This information shall be submitted at the Shop Drawing stage.

.5 Documentation provided by the Contractor shall be formatted as follows:

.1 *Piping and Instrumentation Diagram (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 *Input/Output 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 Diagram (ILD)* – Shows typical interconnections and hook-up of devices. The Contractor is to produce an ILD for each device and record all relevant information on each sheet. Fill in all terminal and wiring numbers etc.

.6 *Location Drawings* – Indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the Installer 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.

.6 Definitions

.1 Interpret specialized terms not explicitly defined herein in accordance with Instrumentation Society of America (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.

.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 RP12.6-87	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
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 (NEC)
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 Electrical: Division 16

.9 Codes, Rules, Permits and Fees

.1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.

.2 Comply with all rules of the electrical Safety Act of the Province, Canadian Standards Association (CSA) Standards, Underwriters Laboratories of Canada (ULC) and the applicable building codes, whether specifically shown on Drawings or not.

.3 Give all required notices, submit Drawings, obtain all permits, licenses, and certificates, and pay all fees required for this Work.

.10 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 Install Products in accordance with the recommendations and ratings of the Product Manufacturers.

.3 Supply and execute installation of all instrumentation control tubing in accordance with Division 17.

.11 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply all items and accessories specified by the Drawings or the Specification in the quality and quantity required. Perform all operations as designated by the Specification according to the methods prescribed, complete with all necessary labour and incidentals.

.3 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. Provide such specified items or subjects.

.4 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.

.5 If discrepancies or omissions in the Drawings or Specifications are found, or if intent or meaning is not clear, consult the Contract Administrator for clarification before submitting tender.

.6 The 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.

1.2 Equipment

.1 Perform a preliminary examination upon delivery to ensure that:

.1 All I&C components supplied for this project under this Section of the Specification comply with the requirements stated in the Specifications.

.2 All I&C components supplied under other Sections of this Specification, to be connected to I&C components supplied under this Section of the Specification, comply with the requirements stated in the Contract documents.

.2 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.

.3 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.

.4 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. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

1.3 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 them 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 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.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1**.**

.2 Selected Products.

.1 Provide Products and materials that are new and free from all defects.

.2 Products and materials called for on the Drawings or in the Specifications by trade names, Manufacturer's name and catalogue reference are to be used as the basis for the Tender.

.3 Quality of Products

.1 All Products provided to be CSA approved 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.

2.2 Instrumentation

.1 General

.1 Instruments 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 For direct current wiring use black for positive and white for negative.

.7 For thermistor wiring to motors use red and blue coloured insulated wire.

3. EXECUTION

3.1 Coordination With Other Divisions

.1 Examine the Drawing 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 Layout 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.

3.2 Separation of Services

.1 Maintain separation between the electrical wiring system 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 Classifications of Circuits

.1 The circuit categorization shall of first priority follow Canadian Electrical Code (CEC) 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 (>200A) LV circuits.
	Harmonic-rich LV circuits.
	DC circuits: un-suppressed or above 50V.
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).

.3 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

3.3 Wire and Cable

.1 Refer to **Section 17124 –** Instrumentation Cable.

3.4 Equipment Connections

.1 Control circuits may vary with different Manufacturers of equipment. Verify all control circuits with the Manufacturers of the equipment and make any corrections to the control wiring diagrams that may be required.

.2 Provide power disconnect switches for all 120 VAC powered instruments.

3.5 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.

3.6 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 defined the Contract Administrator will provide naming and numbering that is consistent with the plant naming conventions.

3.7 Training

.1 Provide training, described in detail in Division 1, as required by the plant's personnel to become fully competent in the proper operation and maintenance of all control devices, control valves, and ancillary instrumentation described under this Section of the Specification.

.2 For the PLC based control system, the Contractor shall provide maintenance training that includes a review of the PLC program, system troubleshooting, and identification of programmed system variables such as setpoints, alarms, and status.

3.8 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: _____

3.9 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 plant control and monitoring system.

.5 Where applicable, test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.6 Perform tests and record results on test data forms which 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) working days of testing.

3.10 Calibration

.1 Instruments to be factory pre-calibrated. 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 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 ½ of 1% of full range, or to the Manufacturer’s state accuracy of the instrument whenever an accuracy of ½ of 1% is not achievable.

.5 Prior to instrument installation perform the following applicable calibration for each instrument and its associated signal conditioning equipment:

.1 Calibrate all inline flowmeters 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 sample.

.5 Calibrate temperature instruments against a standard lab thermometer.

3.11 Installation and Performance Testing

.1 During commissioning, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges.

.2 Commissioning of the I&C system 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 report.

.4 Function check and adjust under operational conditions the I&C equipment.

.5 Coordinate I&C equipment supplier's service personnel as required for complete system testing.

.6 Instruct plant personnel in correct method of operation of I&C equipment.

.7 Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

.8 Ensure that the I&C equipment suppliers 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 to commission the interface between the Plant supervisory control and data acquisition (SCADA) and the packaged PLC based control system.

END OF SECTION

SCOPE OF SUPPLY

1. GENERAL

1.1 Requirements of Work

.1 This Section describes the Instrumentation and Control (I&C) scope of supply for the Dissolved Air Flotation (DAF) and Flocculation Equipment control system.

.2 The Contractor shall furnish all necessary components to provide a complete and fully functioning DAF and Flocculation Equipment control system.

1.2 Process Area Environment

.1 Refer to **Section 16015** for detailed information.

1.3 Scope of Supply

.1 For the DAF and Flocculation Equipment control system the Contractor shall provide the following:

.1 Local Control Panels for each DAF and Flocculation unit to allow local control of each DAF and Flocculation unit.

.2 The data communication link between the Local Control Panels and any other Control Panel shall be Modbus/TCP via Ethernet.

.3 All instruments used for monitoring and control of each DAF and Flocculation Equipment.

.4 All instruments (temperature, vibration, and others as required) for personnel safety and equipment protection.

.5 Emergency Shutdown (ESD) pushbutton for each DAF and Flocculation unit.

.6 Additional Supervisory Control and Data Acquisition (SCADA) System interface requirements over and above what is described in Section 17010, part 2.3:

.1 Provision for Remote (from the SCADA) START/STOP command for each DAF and Flocculation unit.

END OF SECTION

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 American National Standards Institute (ANSI) 61 Grey as specified in Division 11.

.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 Supply Electrical & Electronic Manufacturers Association of Canada (EEMAC) Type twelve (12) gasketted enclosures in MCC rooms and control rooms.

.2 All enclosures for mounting outside of ozone motor control centre (MCC) rooms and control rooms to be EEMAC Type four (4), watertight except where otherwise specified.

.3 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).

.4 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.

.5 Enclosures for mounting field control indicator lamps and switches in Class one (1) areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

2.3 Panel Enclosures

.1 Fabricate panel enclosures from eleven (11) gauge steel panels complete with necessary stiffening to form a rigid free-standing line-up. 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 Supply panels with front access only. Doors shall be key lockable and fitted with three (3) point heavy duty latching assemblies. Provide a continuous piano hinge and 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 Marshalling 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 panel fabricator.

.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.

2.5 Wiring and Accessories

.1 Provide wiring inside the panels according to the following Specifications:

.1 Control wiring to be a minimum of No. 16 American wire gauge (AWG) tinned stranded copper; insulation rated at 300 V.

.2 Wiring for power distribution shall be a minimum of No. 14 AWG tinned stranded copper; insulation rated at 600 V.

.3 Refer to Division 16 for cable routing requirements.

.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 wireways such as Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed 40% of the cross sectional area of the wireway.

.5 Provide a minimum clearance of 50 mm between wireways 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:

.1 Wire identification to use the connected field device tag name with the wire's corresponding terminal number appended to it.

.2 Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.

.3 For example, pressure transmitter PPT-100A located in the field has a 2PR-TPSH cable connected to it. The cable runs through a junction box to a marshalling panel. The wire identifiers for the pair of wires would start with PPT-100A all the way to the marshalling panel.

.4 Identify spare wires by using the destination identifier, cable tag and terminal number. For the example above, spare conductor on terminal three (3) would be tagged PPT-100A-3.

.5 Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wire connections are made on the outboard side.

.7 Provide a 120 VAC panel power distribution system 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 W Series type to isolate field wiring that is powered from the panel.

.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 colour coded as follows:

Red	=	positive 24 VDC.
Black	=	analog signal plus.
White	=	analog signal common and VAC neutral.
Grey	=	120 VAC.
Green	=	ground.

.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 (3) lines of 3 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 marshalling panel.

.2 Provide grounding lugs for each panel, suitable for termination of up to No. 2 AWG copper grounding conductor.

.3 Provide in each marshalling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two (2) No. 2 AWG grounding conductors.

.4 Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels 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 three (3).

END OF SECTION

INSTRUMENTATION CABLE

1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Division 1 and Division 16.

.2 Instrument cables shall be supplied and installed for all instruments that are connected to the local control panels and equipment located on the same skid. For example, if the air compressor is supplied on a skid with a local control panel, the pressure switches located on that compressor shall come pre-wired to the local control panel.

1.2 Standards

.1 All wire and cable shall be Canadian Standards Association (CSA) approved.

2. PRODUCTS

2.1 Twisted Pair Shielded Cables (TPSH)

.1 TPSH shall be constructed as follows:

.1 Two (2) copper conductors, stranded, minimum No. 18 American wire gauge (AWG), poly vinyl chloride (PVC) insulated, twisted in nominal intervals of 50 mm.

.2 Insulated for 600V, 90°C.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire, minimum No. 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 approved type or Beldon equivalent.

.2 Where multiconductor 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 RTD and Multi Conductor Shielded Cable

.1 RTD cables shall be CSA approved and shall be constructed as follows:

.1 Three (3) or more copper conductors, stranded, minimum No. 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 CSA-C22.2

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH cable for all low level analog signals such as 4-20 mA, pulse type circuits 24 VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTD's and transmitters or PLC RTD inputs.

3.2 Digital Signals

.1 Use TPSH cable for all low level input (24 V and below) and output signals.

.2 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.

3.3 Installation

.1 Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 300 mm length of liquid tight flexible conduit to connect the field sensors to the conduit.

.2 Where non-armoured 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.

3.4 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.

3.5 Testing

.1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable Manufacturer.

3.6 Identification

.1 Identify all instrumentation cables.

.2 Identify each conductor with wire numbers using a machine printed heat shrink wire marker, similar to Raychem TMS.

END OF SECTION

1. GENERAL

1.1 References - General

.1 Refer to **Section 17010**.

2. PRODUCTS

2.1 Power Supply and Conditioning Equipment

.1 General

.1 Provide all direct current (DC) power supplies as required for all instrument circuits. All circuits to be powered from the marshalling panels. Power supplies to be equal to Hammond or G.F.C., complete with an over-voltage protection module.

.2 Provide redundant configurations for power supply equipment serving more than one (1) 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.

.3 Power supplies and transmitters feeding circuits that run in non-armoured cable in cable tray shall meet the requirements for Class two (2) circuits as defined under Division 16 of the CEC Part one (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 volts on the panel direct current bus. Size the power supply for two (2) times the connected load, minimum size is two (2) Amps.

.5 Provide transient voltage surge protection devices as manufactured by Leviton or equal on all panel assembly power input lines. Provide power line conditioning equipment on all main power supplies to control panels; Sola or equal.

2.2 Noise Suppression

.1 Provide power conditioners in each panel to power alternating current (AC) instrumentation and control loads. Power conditioners are Oneac Series CX.

2.3 Uninterruptible Power Supply

.1 No uninterruptible power supply (UPS) unit is required.

.2 120 V AC power supply wiring for the equipment controller [i.e., programmable logic controller (PLC)] and instruments. 120 V AC or 120 V AC/24 V DC power supplies shall be terminated in separate fused terminals.

.3 Separate UPS power may be provided from an external UPS power source.

.4 The controller and the instruments shall stay energized when the main power source to the equipment is disconnected or has failed.

.5 All the 120 V AC circuits shall be sized assuming that the controller and the instruments may be powered from the panel. Provide 120 V AC spare terminals where the controller and the instruments may be powered from if this option is chosen.

.6 Provide a lamacoid on the control panel indicating "More than one power source in the panel".

.7 Provide power consumption data for the 120 V AC circuit for the controller and the instruments so the external UPS unit can be properly sized.

.8 If the equipment controller has to be initialized after power has been restored, then provide additional digital input to the controller which will monitor the main power to the equipment and will be programmed to execute the initialization routine when the main power to the equipment has been restored.

3. EXECUTION

3.1 References – General

.1 Refer to **Section 17010 -** Instrumentation and Control General Requirements, Part three (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**.

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 and rated for the service in which they are to be employed. Tubing and fittings 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 Fisher approved air sets or approved equal.

.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.

.2 Solenoid enclosures to be minimum Electrical & Electronic Manufacturers Association of Canada (EEMAC) 4; corrosive areas require EEMAC 4X and hazardous areas require EEMAC Type 9.

.3 Provide manual overrides on coils when solenoid is used to actuate a valve.

.4 Standard coil voltage: 120 VAC.

.5 Pipe size: Three (3)-way valve – 6 mm; four (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, Part three (3).

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 Provide pressure gauge and thermowell tapping requirements in accordance with Division 11.

2.2 Primary Elements

.1 Provide written assurance that the instrument Manufacturer approves the selection of materials of primary elements, which are in contact with the specified process fluid, to be inert to the effects of the process fluid.

.2 Provide drip pots installed below sensing elements measuring gas. Provide seamless stainless steel drip pots consisting of a 50 by 300 mm pipe with an isolating valve and a drain valve. Provide a separate drip pot for each sensing line. Locate the drain valve within 500 mm of the floor.

.3 Provide diaphragm seals on any fluid other than clean water or glycol.

.4 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.

.5 Provide 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 Control General Requirements.

2. PRODUCTS

2.1 Transmitters and Indicators

.1 Transmitters shall have adequate power output to drive all devices associated with that signal loop. Provide signal boosters as required to achieve adequate signal strength or to isolate the signal.

.2 All transmitters to have local indication scaled in engineering units as specified in the engineering Specifications. Provide a lamacoid label indicating the calibrated range and engineering units and mount adjacent to the transmitter. Mount the transmitter so the indicator is visible by the operator.

.3 Remote indicators similar to Action Instruments model V560 for use in unclassified areas. Action Instruments model V560-EP for use in class one (1) areas is acceptable.

.4 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.

.5 Where available as an option, the transmitter shall be supplied with an isolated fault contact.

.6 Standard of acceptance for instrumentation shall be as follows:

.1 Level Transmitters: Ultrasonic type: Siemens Multiranger 100/200.

.2 Pressure Transmitters: Rosemount Model 3051, or Bailey Platinum Series complete with stainless steel two (2) and three (3) valve manifolds as manufactured by Anderson Greenwood or Endress and Hauser.

.3 Dissolved Oxygen (DO) Sensors: GLI International, Royce Instruments, or Capital Controls.

.4 Flow Transmitters: Magnetic flow transmitters by Fischer and Porter, Rosemount 8700 Series, ABB, or Endress and Hauser.

.5 pH Sensors: ,ABB, Endress and Hauser, or Foxboro 870 Series.

.6 Turbidity Sensors – Hach Company.

3. EXECUTION

3.1 References - General

.1 Refer to **Section 17010 -** Instrumentation and Control General Requirements, Part three (3).

END OF SECTION

POWERED ACTUATORS

1. GENERAL

1.1 Work Included

.1 Supply, installation, and testing of electric and/or pneumatic powered actuators and accessories for controlled devices such as valves, gates, dampers etc.

.2 Sizing and selection of modulating control valve components.

.3 Size and match powered actuators to controlled devices.

1.2 Submittals for Review

.1 Submittals in accordance with Division 1 and **Section 17010** – Instrumentation and Control General Requirements**.**

.2 Furnish Shop Drawings for complete actuator assemblies and accessories prior to delivery.

.3 Provide calculations for sizing, noise, cavitation, and actuator torque calculations, etc., in addition to the requirements of Division 11.

.4 Submit a completed ISA S20.50 Instrument Specification Sheet for each device.

1.3 Submittals For Information Only

.1 Submit the following in addition to the requirements of Division 1 and **Section 17010** - Instrumentation and Control General Requirements.

.1 Factory calibration and testing reports. Handwritten reports not to be accepted.

.2 Operations and maintenance manuals in accordance with Division 11.

1.4 Service Conditions

.1 Provide electrical enclosures rated for wet and corrosive areas.

.2 Control air to be instrument quality, oil free, supplied between 555 kPa minimum to 810 kPa maximum pressure.

.3 Refer to **Section 17010** - Instrumentation and Control General Requirements for additional details.

1.5 Shipment, Protection, and Storage

.1 Ship and store equipment in accordance with Division 1 and **Section 17010** - Instrumentation and Control General Requirements.

1.6 Delivery and Storage

.1 Deliver valves and actuators to Site use loading methods which do not damage casings or coatings.

.2 Clearly tag all control valves and actuators, stating size, type, coatings, and mating parts.

.3 When stored on-site, use storage methods recommended by the Manufacturer to prevent damage, undue stresses, or weatherproofing.

2. PRODUCTS

2.1 General

.1 Provide new material only.

.2 Provide all actuator mounting hardware and accessories mounted on the device prior to shipment.

.3 Provide actuators of National Electrical Manufacturers Association (NEMA) 4 construction, suitable for use in an industrial environment.

.4 Provide device and actuator as a matched set from the same Manufacturer wherever possible.

.5 Where available, the actuators shall be provided with Modbus/TCP communications capability.

.6 Tag the control devices, accessories and actuators to indicate operating characteristics. Tag the actuator inlet and outlet ports for electric or pneumatic services. Electric actuators must be Canada Standards Association (CSA) approved.

.7 Refer to **Section 17140 –** Instrument Air Supply and Transmission for air sets.

.8 Refer to **Section 17140 –** Instrument Air Supply and Transmission for solenoid valves.

2.2 Actuator Types

.1 Pneumatic Diaphragm Actuators - General

.1 Provide diaphragm quarter turn and linear actuators capable of continuous duty over the full operating range.

.2 Unless specified otherwise, the actuators shall fail to the open position when the control function fails or when pressure is removed from the actuator diaphragm.

.3 Each actuator to be capable of operating in any horizontal or vertical orientation.

.4 When manual actuation is specified fit each actuator with a hand wheel, mounted in line with the valve shaft, which will enable manual override control of the valve.

.5 House all internal components in a cast iron enclosure, drip-proof and corrosion-proof.

.2 Pneumatic Diaphragm Quarter Turn Actuators, Modulating Type (PDQM)

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for modulating service.

.3 Pneumatic Diaphragm Linear Actuators, Modulating-Type (PDLM)

.1 Diaphragm operators to be suitable for mounting on sliding-stem valves and dampers requiring linear actuation intended for modulating service.

.4 Pneumatic Diaphragm Quarter Turn Actuators, Open/Close-Type (PDQO)

.1 Diaphragm operators to be suitable for mounting on quarter turn valves intended for on/off service.

.2 Provide a solenoid valve, an airset, and accessories.

.3 Provide two (2) needle valves (snubbers) for each actuator. The needle valves to control instrument air flows such that the actuator travels a full stroke within a time range adjustable from one (1) to thirty (30) seconds with separate adjustments for each direction of travel.

.5 Pneumatic Piston Actuators - General

.1 When manual actuation is specified, fit each actuator with a hand wheel to enable manual override control of the valve.

.2 Each actuator to be capable of operating in any horizontal or vertical orientation.

.3 House internal components in a cast iron enclosure, drip-proof and corrosion proof.

.4 Where valves are intended to fail open or closed, provide spring-loaded actuators. Where they are intended to fail to last operating position, provide double acting actuators.

.6 Pneumatic Piston Quarter Turn Actuator, Modulating Type (PPQM)

.1 Piston actuators to be suitable for mounting on quarter turn valves or dampers intended for modulating service.

.7 Pneumatic Piston Quarter Turn Actuator, Open/Close Type (PPQO)

.1 Piston operators to be suitable for mounting on quarter turn valves or dampers intended for on/off service. Sector types are not permitted

.2 Provide actuator accessories such as limit switches and position switches.

.3 Provide two (2) needle valves (snubbers) for each actuator. The needle valves to control instrument air flows such that the actuator travels a full stroke within a time range of one (1) to thirty (30) seconds with separate adjustments for each direction.

.8 Electro-Mechanical Actuators, General

.1 Unless otherwise specified, electric actuators to be 120 V/-1 ph/60 Hz for service where required torque is less than 115 N.m and 3 ph/60 Hz for service with torque above 115 N.m. Provide each actuator with a high torque, reversible motor which is capable of continuous duty over the full operating range.

.9 Electric Quarter Turn Actuators, Open/Close Type (EMQO) and Modulating Type (EMQM)

.1 Provide electric operators suitable for mounting on quarter turn valves or dampers intended for on/off and modulating service.

.2 Provide each actuator with built-in motor overload protection.

.3 Fit each actuator with a hand wheel which will enable manual override control of the valve.

.4 Each actuator to be capable of operating in any horizontal or vertical orientation.

.5 Provide external mechanical indication of valve position. Provide an external visual position indicator for each positioner.

.6 House internal components in an Electrical & Electronic Manufacturers Association of Canada (EEMAC) 4 enclosure, moisture-resistant and corrosion-resistant. Internal components to be permanently lubricated.

.7 Motors will be rated at 20% intermittent duty cycle.

.8 For remote indication provide the actuator with two (2) SPDT travel limit switches, 10A, 125V AC, CSA listed. The travel limit switches to be adjustable.

.9 Provide the actuator with two SPDT torque limit switches, 10A, 125 V AC. The torque limit switches to be factory preset and field adjustable.

.10 Provide adjustable mechanical limit stops to ensure over-turning of the valve does not occur.

.11 Protect exterior mounted actuators against low temperature and condensation.

.12 The actuator speed will be field adjustable.

.13 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve.

.14 Modulating actuators to accept a 4 to 20 mA control signal for remote proportional control.

.10 Electric Linear Actuators, Open/Close Type (EMLO) and Modulating Type (EMLM)

.1 Electric actuators for gates to be comprised of an electric motor and one (1) or two (2) gear boxes, depending on the gate design.

.2 Provide a sufficiently sized motor to seat and unseat gates and, if necessary, for control to traverse from full open to full closed position in small increments, in response to control signals.

.3 The actuator will impart a travel speed of 2.5 m/hr to modulating gates and 18.0 m/h to open/close gates unless otherwise specified on the Instrument Specification Sheet (ISS). The actuator speed to be field adjustable.

.4 The actuator shall be fully compatible with the gate. Mount at operating height on the frame.

.5 Actuators to accept 3 phase/60 Hz power. Protect motors against reversed phase rotation.

.6 Modulating actuators to accept a 4-20 mA control signal for remote proportional control of gate opening.

.7 The drive train to be rated for heavy duty, continuous service. Connect the actuator drive shaft to gear box shaft(s) through a removable flexible mechanical coupling. Where the actuator is fitted to two stems, ensure that the gearing in each gearbox allows both stems to move identically.

.8 House the internal components of actuators and related gear boxes in weather proof, corrosion proof metal enclosures. Electrical components to be contained in EEMAC six (6) enclosures. All electrical and mechanical components shall be capable of continuous operation in an ambient temperature range of -40°C to plus 40°C.

.9 Provide a space heater for each actuator.

.10 Fit actuators with a capstan hand wheel operator. Fit hand wheel assemblies with a clutching mechanism which prevents hand wheel operation during normal motor operation. Provide a one (1) to one (1) gearing ratio with respect to the main drive shaft for the hand wheel.

.11 Fit removable safety guards over all moving drive train components between the actuator and each gear box.

.12 Provide adjustable limit switches on each actuator to define the upper and low limit of the stroke.

.13 High torque switches will protect the equipment and the structure against excessive gate travel. Provide high torque protection at the lower and upper ends of the stroke.

.14 Provide a controller enclosure to contain a motor contactor complete with overload protection. Provide line, load, and external control terminal strips.

.15 Provide a local operating station with a Local-Off-Remote switch and an Open-Close switch

2.3 Current to Pneumatic (I/P) Converters

.1 Provide I/P converters where required, as indicated on the Drawings.

.2 Supply all required hardware for mounting the I/P on the controlled device.

.3 I/P converter to be of EEMAC 4 construction or as specified in the ISS.

.4 I/P converter to operate with instrument quality, control air at an operating pressure range of 20 to 200 kPa.

2.4 Valve Positioners

.1 Supply compatible positioners pre-mounted to each actuator. Do not amount the positioner upside down.

.2 Each positioner to service the entire operating range of the actuator. The equipment position shall be fed back to the positioner through a mechanical linkage.

.3 Positioner to operate with instrument quality, oil-free control air.

.4 Provide three independent, interchangeable cams for each positioner -linear function, square function, and square root function.

.5 Mount a pressure gauge on the positioner to measure air output.

2.5 Position Switches and Indicators

.1 Actuator position switches shall include two (2) form C 2 amp contacts in an EEMAC four (4) (minimum) rated enclosure.

.2 Cams to be fastened to a splined shaft and adjustable without set screws.

.3 Provide a visual indicator with beacon type display showing red when the controlled device is closed position and green in open.

.4 Supply all required hardware for mounting of position monitor in accordance with the specified valve/actuator orientation.

.5 Diaphragm actuated valves to have external position monitor actuated through linkages.

.6 Enclosures to be suitable for environment to which they are exposed.

2.6 Manual Loading Station

.1 Manual loading station shall consist of a manually adjustable loading regulator, changeover valve (manual/automatic), a gauge for manual signal pressure indication, a gauge for automatic signal pressure indication, an air set, and air supply isolating valve.

.2 Mount loading station on a galvanized plate attached to a floor stand. Locate station within 2 m of the controlled device.

2.7 Minimum monitoring and control signal requirements

.1 Open Close actuators:

.1 Momentary Open Command (Remote dry contact).

.2 Momentary Close Command (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.

.2 Modulating actuators:

.1 Input signal: 4-20 mA from programmable logic controller (PLC).

.2 Output signal: 4-20 mA to PLC for position monitoring.

.3 Computer (Remote) Mode (Dry contact for remote indication).

3. EXECUTION

3.1 Field Testing and Commissioning

.1 Provide testing and commissioning assistance in accordance with Division 1 and **Section 17010 –** Instrumentation and Control General Requirements, Part three (3).

.2 Factory test each actuator assembly prior to shipment.

.3 The Manufacturer's Representative will be required to commission the electric and/or pneumatic actuators to verify the installation and make final travel limits and torque adjustments.

3.2 Training

.1 Provide training in accordance with Division 1.

END OF SECTION

SWITCHES AND RELAYS

1. GENERAL

1.1 References - General

.1 Refer to **Section 17010**.

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 National Electrical Manufacturers Association (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 Electrical and Electronic Manufacturer's Association of Canada (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 types.

.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.

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, provide signal conditioning modules that comply with the following requirements, unless otherwise specified:

.1 Analog signal inputs: 4-20 mA DC into 500 ohms.

.2 Analog signal outputs: 4-20 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 Provide electronic trip modules with L.E.D. 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 Refer to **Section 17213 –** Powered Actuators, Item 2.3.

3. EXECUTION

3.1 References – General

.1 Refer to **Section 17010 –** Instrumentation and Control General Requirements, Part three (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 Provide panel instruments with the following requirements, unless otherwise specified:

.1 Analog instruments to be miniature case, drawout 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, L.E.D. 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 4-20 mA direct current (DC).

.5 Analog signal outputs to be 4-20 mA DC into 500 ohms.

.6 Galvanically isolate the signal and power supply from the instrument case.

.7 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, Part three (3).

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 Provide pilot lights of the transformer type for extended lamp life, oil tight, push to test, complete with appropriate colour lenses. Normal colours used are run = red, stop = green unless otherwise depicted elsewhere. Refer to Division 16 for additional information

.2 Terminals

.1 Provide strap screw type terminal blocks rated for 600 volts.

.2 Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.

.3 Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors equal to Panduit PAN-TERM series or T&B STA-KON series.

.4 Terminals to be Wiedmuller.

.5 Provide a group of terminals for each of 120 VAC 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. Provide nickel-plated terminals for all high capacity applications in excess of 15 A.

.6 Provide Wiedmuller 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 part 2.3.1 for nameplate Specification.

2.2 Signal Current Isolator

.1 Isolator to provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits.

.2 Isolator to 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 to be 4 to 20 mA DC, with an error not exceeding 0.1% of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.

.4 Isolator to be Moore Industries.

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, Stahl, P&F series.

.2 Provide dual type intrinsic safety barriers for process switches: MTL, Panalarm.

.3 Intrinsic safety relays to be Gems or Warrick.

3. EXECUTION

3.1 References - General

.1 The Contractor shall provide a tabulated list of all consumables utilized such as fuses, lamps, bulbs, etc., indicating where used, type, rating, and reorder details. Include with the operation and maintenance manual information.

END OF SECTION

PLC AND OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 Requirements - General

.1 Design, supply, and installation of a programmable logic controller (PLC)-based control system for the Dissolved Air Flotation (DAF) and Flocculation Equipment that will control and monitor the system in accordance with the requirements defined by the Contract Documents.

.2 PLC's and Inputs/Outputs (I/O) sub-systems shall be housed in a central marshalling panel to be located adjacent to treatment area.

.3 PLC's shall be programmed using the latest version of Schneider Electric's Unity Programming Software. The program shall be fully documented and programmed according to standards that will be provided by the Contract Administrator.

.4 The final PLC configuration program shall be provided to the City on compact disk.

.5 Start-up and commissioning assistance as required for the control system.

2. PRODUCTS

2.1 PLC's

.1 General

.1 All new PLC equipment to be based on the Modicon Unity Processor family as applicable (no substitutions allowed).

.2 All processors are to be sized to provide sufficient capacity to handle the logic and data requirements plus an additional 50% spare central processing unit (CPU) memory.

.3 Communication protocol for the new PLC network to be Modbus/TCP.

.4 Digital Inputs shall meet or exceed the following criteria:

.1 120 VAC input signals.

.2 Individually isolated.

.3 Status indicator light for each input.

.4 Terminal strip.

.5 Digital Outputs shall meet or exceed the following criteria:

.1 Normally open contacts.

.2 Individually isolated.

.3 120 VAC, 4A rating.

.4 Status indicator light for each output.

.5 Terminal strip.

.6 Analog Inputs shall meet or exceed the following criteria:

.1 4 to 20 mA DC isolated.

.2 12-bit analog-to-digital converter.

.3 Accuracy of 0.5% of input range or better.

.4 Input impedance of 250 ohms or less.

.5 Terminal strip.

.7 Analog Outputs shall meet or exceed the following criteria:

.1 4 to 20 mA DC isolated.

.2 12-bit analog-to-digital converter.

.3 Accuracy of 0.5% of output range or better.

.4 Load driving capability of 500 ohms or more.

.5 Terminal strip.

.8 Modbus/TCP will be used as the PLC to PLC and PLC to supervisory control and data acquisitions (SCADA) communication protocol.

.9 Provide at least 20% spare I/O of each type in each panel assembly.

.10 Provide all necessary racks, power supplies, cables, communication cards, and accessories.

.11 Provide spares of all PLC system components (minimum of one of each exact type) supplied including: power supply, processor, communication modules, and input/output modules.

.12 Provide 10% spare slot capacity for each PLC panel assembly.

.13 Provide 25% spare power supply capacity for each PLC panel assembly.

.14 Each new PLC panel assembly is to include a true on-line uninterruptible power supply (UPS) system suitably suited to maintain the panel load for at least sixty minutes and; incoming power transient surge suppression equal to Sola Hevi-Duty STV100K series. 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 CPU.

.2 Modicon NOE (Modbus/TCP) modules for each processor rack.

.3 I/O modules to meet the specifications defined above and the I/O requirements of **Section 11490**, 11.

2.2 System Integration Requirements

.1 Cooperate with other Contractors, City staff, and consultants to facilitate installation, testing, validation, and commissioning of the DAF System.

.2 Supply, Install, test, and commission 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 DAF PLC's. Test data exchange with the PLC as defined in this Section and the process description.

3. EXECUTION

3.1 References – General

.1 Refer to **Section 17010**, Part three (3).

END OF SECTION

SCADA 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 The Supervisory Control and Data Acquisition (SCADA) system will be supplied, installed, programmed, and commissioned by others. The SCADA system will interface to the Dissolved Air Flotation (DAF) system to allow complete remote monitoring and control consistent with the requirements of this document. The control of the DAF system will be integrated into the SCADA control system to become part of the overall plant-wide control system.

.2 This Contractor is to support the design, installation, programming, and start-up of the SCADA as follows:

.1 Supply all necessary field instrumentation associated with the DAF to facilitate monitoring and control of the system.

.2 Provide all necessary local controls at the DAF to allow local operation such that it compliments the operation of the SCADA to facilitate satisfactory system control consistent with the DAF system and the intent of this Specification. The extent of local controls to be provided shall be fully described as part of the submittals defined in Division 11.

.3 Provide all hardware interfaces required to facilitate the interconnection of the DAF system to the SCADA.

.4 Provide all written descriptions and associated Drawings necessary to fully describe the detailed operation of the entire DAF system and to allow the development of application software on the SCADA by others. This includes the control logic software, operator interface software, alarm monitoring, data acquisition, long-term data storage, and performance monitoring software as applicable.

.5 Provide technical assistance during the entire process of SCADA equipment selection, installation, programming, commissioning, and start-up as it relates to the DAF to allow the successful integration of the DAF operation into the plant as a whole.

.6 Update all DAF system documentation at the completion of commissioning and start-up to reflect the final installation.

.3 For the purpose of this project, the following tag name convention will be used:

PAB-123C

Where P is the fixed process area designation "P", A and B are the ISA alpha device function designation based on the Instrument Systems Automations Society (ISA) identification table located at the end of this Section, the succeeding three (3) digits are to be used to identify the system loop number (001 to 999); and the final alpha character will be used as a modifier for duplicate devices on the same loop. Coordinate the implementation of the tag number system with the Contract Administrator.

2. PRODUCTS - NOT USED

3. EXECUTION

3.1 Performance – General

.1 Refer to **Section 17010**, Part three (3).

3.2 Installation

.1 Provide hardware in accordance with the foregoing requirements in sufficient quantity to satisfy the performance requirements defined in this and other Divisions of this Specification.

.2 Provide all necessary documentation to define the configuration of the control system for the DAF including I/O lists, alarm lists, critical process variables, instrumentation lists, loop wiring requirements for I/O, local control equipment details, and detailed system operation descriptions.

.3 Assist with commission and start-up the system as defined herein.

.4 Provide all documentation and training as defined herein.

ISA TABLE 1 - IDENTIFICATION LETTERS

	First-Letter	Succeeding-Letters	
	Measured or Initiating Variable	Readout or Passive Function	Output Function
A	Analysis	Alarm	
B	Burner, Combustion	User's Choice	
C	Conductivity		Control
D	Density		
E	Voltage	Sensor (Primary Element)	
F	Flow Rate		
G		Glass Viewing Device	
H	Hand		
I	Current (Electrical)	Indicate	
J	Power		
K	Time, Time Schedule		Control Station
L	Level	Light	
M	Moisture		
N	User's Choice	Operating or On/Off	
O		Orifice, Restriction	
P	Pressure, Vacuum	Point (Test) Connection	
Q	Quantity		
R	Radiation	Record	
S	Speed, Frequency		Switch
T	Temperature		Transmit
U	Multivariable	Multifunction	Multifunction
V	Vibration, Mechanical Analysis		Valve, Damper, Louver
W	Weight, Force	Well	
X	Unclassified	Unclassified	Unclassified
Y	Event, State or Presence		Relay, Compute, Convert
Z	Position, Dimension		Driver, Actuator, Unclassified Final Control Element

END OF SECTION