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DIVISION 01

Reviewed and Approved

Date

FIELD ENGINEERING

1. REQUIREMENTS INCLUDED

.1 Field engineering survey services to measure and stake the Site.

.2 Survey services to establish (and confirm) invert measurements for the Work.

.3 Subsurface conditions.

2. QUALIFICATIONS OF SURVEYOR

.1 Qualified Registered Land Surveyor.

3. SURVEY REFERENCE POINTS

.1 Existing base horizontal and vertical control points are designated on Drawings.

.2 Locate, confirm, and protect control points. Preserve permanent reference points during construction.

.3 Make no changes or relocations without prior written notice to the Contract Administrator.

.4 Report to the Contract Administrator when a reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.

.5 Require Surveyor to replace control points in accordance with the original survey control.

4. SURVEY REQUIREMENTS

.1 Establish two (2) permanent benchmarks on-site, referenced to establish benchmarks by survey control points. Record locations with horizontal and vertical data in Project Record Documents.

.2 Establish lines and levels; locate and lay out by instrumentation.

.3 Stake for grading, fill and topsoil placement, and landscaping features.

.4 Stake slopes and berms.

.5 Establish pipe invert or centerline elevations.

.6 Establish lines and levels for mechanical and electrical Work.

5. RECORDS

.1 Maintain a complete accurate log of control and survey Work as it progresses.

6. SUBMITTALS

.1 On request of the Contract Administrator, submit documentation to verify accuracy of field engineering Work.

.2 Submit certificate signed by Surveyor certifying that elevations and locations of completed Work are in conformance or non-conformance with Contract Documents.

END OF SECTION

SCOPE OF WORK

1. DESCRIPTION OF WORK

.1 The Work to be performed under this Contract shall include the labour, equipment, and materials required to complete the Secondary Effluent Ultraviolet (UV) Disinfection Facility at the North End Water Pollution Control Centre (NEWPCC) in Winnipeg, Manitoba, all as specified in the Contract Documents.

.2 The Work includes, but is not limited to the following elements:

.1 New structure with associated mechanical and electrical systems to house the UV disinfection equipment.

.2 New structures to accommodate the five (5) UV influent pumps.

.3 New effluent sampling facility to house City of Winnipeg (City) supplied equipment.

.4 Tie-in to existing secondary effluent system to feed to, and drain the new pumps and disinfection systems.

.5 Installation of City supplied UV disinfection equipment and associated electrical and control systems.

.6 Installation of five (5) new City supplied UV influent pumps and associated piping, fittings, variable frequency drives (VFDs), and electrical systems.

.7 Upgrade, additions, and modifications to the electrical supply system and services as detailed in Division 16 Electrical Scope of Work.

.8 Upgrade and modifications to the distributed control system (DCS) to control new systems.

.9 Modification of existing gate YG12B at the Primary Effluent Bypass Junction Structure, including automatic actuator and any required refurbishment or repair.

.10 Supply and installation of flow control gates with associated mounting and operating systems.

.11 Modification to existing effluent gate chamber to extend separation of secondary effluent conduits through entire structure.

.12 Sitework and Site Utility Work associated with the new facilities and with the general Site.

.13 Heating, Ventilation and Cooling (HVAC) systems.

.14 All other auxiliary equipment, structures, and systems required to complete the Work.

2. PRETENDERED EQUIPMENT

.1 The City will be Tendering items of major equipment separately for incorporation in the Work. There are two (2) separate equipment supply Bid Opportunities related to this Work:

.1 Bid Opportunity No. 257-2004. Request for Proposal for the Supply of Ultraviolet Light Disinfection Equipment for the North End Water Pollution Control Centre Disinfection Project. Anticipated delivery date December 1, 2005.

.2 Bid Opportunity No. 89-2005. Bid Opportunity For The Supply Of Vertical Axial Flow Propeller Pumps with Variable Frequency Drives Complete with Fabricated Draft Tube and Interconnecting Pipework for the North End Water Pollution Control Centre Disinfection Project. Anticipated delivery date December 1, 2005.

.2 A copy of the Supply Contracts, Shop Drawings, Schedules, and related correspondence will be issued to the Contractor after award of the Contract.

.3 Be responsible for taking delivery of the materials or taking responsibility for the equipment from the City should the equipment be delivered prior to Contract Award. In addition, be responsible for the installation, testing, and commissioning of the supplied equipment and ancillaries.

.4 Be responsible for the secure transport of City supplied equipment to the UV Facility. The City will store equipment at the NEWPCC until required by the Contractor for installation.

.5 The Equipment Supply Contractors for these Contracts will provide Shop Drawings installation training, installation and testing supervision, and support during commissioning, in accordance with the terms of their Contracts. Provide all remaining supervision, labour, equipment, materials, and services necessary for a successful installation.

3. COORDINATION

.1 Cooperate and liaise with other Contractors, utility agencies, City employees or their appointed representatives in order to make appropriate working arrangements to ensure satisfactory execution and timely completion of the Work.

.2 Attend coordination meetings, as directed by the Contract Administrator, when the Contract Administrator considers that they are necessary for ensuring the sufficiency of the liaison and cooperation with other contractors. The Contractor shall be deemed to have allowed in his Bid Price for any interference to his operations, which may result from any of the above. He must also take all precautions necessary to ensure that he does not hinder or delay in any way the progress of these other parties or cause damage to their completed Work.

4. GENERAL SEQUENCE OF CONSTRUCTION

4.1 UV Influent Pumps

.1 The pump housings (cans, discharge tubes, intake laterals) shall be installed simultaneously with the construction of the adjacent structures (secondary effluent channel and the pump discharge boxes and UV influent channel), to form an integral part of the complete structure.

4.2 UV Disinfection Building

.1 Equipment to be installed in the UV disinfection building Electrical Room, Mechanical Room, and Process Room may need to be installed prior to the completion of the building, specifically prior to construction of the roof. This equipment may include, but is not limited to:

.1 UV Disinfection Reactors

.2 Control Gates

.3 Air handling units

.4 Motor control centres

.5 5kV Distribution

.6 277/480 volt, 3Ø, 4 wire Distribution

.7 600 volt, 3Ø, 3 wire Distribution

4.3 Outfall Tie in

.1 The outfall tie in shall not be made until the pumping and disinfection facilities are complete and fully tied in to the effluent system to the point that secondary effluent can be conveyed through the new Secondary Effluent Channel, through the UV Influent Pumps, through the UV Influent Channel, Distribution Chamber, UV Disinfection Channels and UV Disinfection Effluent Channel.

4.4 Effluent Gate Chamber Baffle Wall

.1 Preparatory Work in the Effluent Gate Chamber may be undertaken at any time when convenient when conditions are suitable, but the dividing structure shall not be permanently fixed until the pumping and disinfection facilities are complete and fully tied in to the effluent system to the point that secondary effluent can be conveyed through the new Secondary Effluent Channel, through the UV Influent Pumps, through the UV Influent Channel, Distribution Chamber, Disinfection Channels, Effluent Channel, Outfall Tie-in and Outfall.

5. CONTRACTOR USE OF PREMISES

.1 Generally restrict operations to the designated construction and contractor laydown areas indicated on the Drawings. Access to the NEWPCC will not be permitted.

.2 The City will make reasonable efforts to accommodate the Work of the Contractor. However, the NEWPCC must remain in operation through the Construction Period.

.3 Obtain written authorization from the respective landowners to enter private lands, which will be the subject of temporary working easements. Obtaining temporary working easements will be the responsibility of the Contractor.

.4 Ascertain and abide by conditions pertaining to the use of temporary working easements or rights-of-way.

.5 Obtain and pay for use of additional storage, access, or work areas needed for Work under this Contract.

6. COMPLETION DATES

.1 Time and all time limits stated in the Contract Documents are of the essence of the Contract. The Contractor shall perform his Work expeditiously and with adequate forces to achieve the completion dates.

END OF SECTION

SITE CONDITIONS

1. SITE CONDITIONS/LIMITS

1.1 Examination of Site

.1 Prior to commencing actual construction Work, inspect field conditions, obtain and confirm actual Site dimensions, examine surface conditions as required to ensure correct execution of the Work.

.2 Maintain or arrange for the removal, relocation, and replacement as appropriate of any existing utilities, which may be affected by the Work.

.3 Arrange for the removal, relocation, and replacement as appropriate, of process piping, equipment, electrical conduit, and concrete pads and supports.

2. DOCUMENTS/INSTRUCTIONS

2.1 Documents Provided

.1 Upon award of the Contract, the Contractor will be provided with five (5) complete sets of the Tender Documents (including Drawings) and two (2) copies of any revised Drawings or Addenda to the Tender Documents, which may have been issued during the Tendering Period. Should the Contractor require additional sets of Drawings or Documents, these will be supplied to him at cost.

2.2 Discrepancies/Omissions

.1 Notify the Contract Administrator immediately upon discovery of discrepancies or omissions in the Contract Documents or of any doubt as to the meaning or intent of any part thereof.

.2 To proceed with the Work when an error is suspected or when there is doubt as to the interpretation of the project requirements constitutes full acceptance of any cost associated with any remedial Work, which may be required.

2.3 Documents On-Site

.1 Maintain one (1) copy of all current Contract Documents and all Shop Drawings on-site, in good order and available to the Contract Administrator or his representatives.

.2 This requirement does not include the executed Contract Documents.

3. CHANGES TO THE WORK

.1 Refer to the Contract General Conditions regarding changes to the Work.

.2 Contemplated Change Notice (CCN): issued after award of Contract, does NOT constitute an order to perform the change but is a notice of a proposed change only. Submit to the Contract Administrator within seven (7) days after receipt of "Contemplated Change Notice" a statement of cost adjustments and effect upon construction schedule required by the proposed change. Itemize statement in accordance with all items separately listed.

.3 Field Order (FO): during Construction, the Contract Administrator may issue a "Field Order" to authorize a change or additional Work of an emergency nature. A firm total cost (extra or credit) or a method for determining this cost must be included (unit price, cost plus or time basis).

.4 Change Order (CO): after receipt of the statement of cost adjustment and the City's approval, the Contract Administrator will issue a "Change Order" in the amount of the approved cost adjustment, which will authorize the Contractor to proceed with the change to the Work, or alternatively will notify the Contractor that the proposed change is cancelled.

.5 Field Instructions (FI): the Contract Administrator may issue during construction, a Field Instruction to supplement or clarify the Contract Documents. Neither the contract price nor the contract time is affected by a Field Instruction.

4. SUBSURFACE CONDITIONS

.1 A copy of the Geotechnical Report with respect to the project is available for review and is for general information only. The contents of this report shall not be construed as a requirement of this Contract. The Bidder shall make his own interpretation of the data provided and shall carry out such additional investigations, as he deems necessary for the preparation of his Bid at his own expense.

.2 The Contractor shall take appropriate precautions to protect existing structures, including but not limited to the existing underground outfall channel, underground effluent gate chamber, and the underground interceptor sewer line that could be affected by subsurface Work.

5. TIE-INS AND MODIFICATIONS TO EXISTING STRUCTURES

.1 The plant may be shut down for short periods under low-flow conditions to facilitate tie-in to the outfall and installation of the effluent gate chamber baffle wall, however, the frequency and duration of these shutdowns cannot be guaranteed. While the City will make every effort to assist the Contractor in this regard, the Contractor shall make allowances to coordinate with the City and to perform such Work in wet conditions with some flow occurring. Dewatering and temporary cofferdams may be required as a part of the Work.

6. SITE PREPARATION

6.1 Description

.1 This Specification shall cover Site preparation, including mobilization, field office facilities, equipment and fuel compounds, Site drainage, access roads, storage areas, and turnarounds, Site contamination and clean-up, demobilization and Site restoration, and other Contractor related tasks required as a portion of the Works for this Contract.

.2 The Work to be done by the Contractor under this Specification shall include the furnishing of all superintendence, overhead, labour materials, all things necessary for and incidental to the satisfactory performance and completion of all Work as hereinafter specified.

6.2 Construction Methods

.1 Use of Public Roads and Right-of-Ways

.1 Maintenance

.1 It shall be the responsibility of the Contractor to keep public roads and right-of-ways used by their construction activities and traffic clean and maintained during the Construction Period.

.2 Earth, gravel, sand or other construction materials spilled from hauling equipment onto public roads and right-of-ways shall be picked up promptly and continuously at the Contractor's expense.

.3 Any damage to public roads and right-of-ways caused by the Contractor's construction activities shall be repaired at the Contractor's expense as directed by the Contract Administrator or the authority having jurisdiction.

.4 Public roads and right-of-ways on the Site are used daily for delivery of septage and other materials. The Contractor shall ensure the roadways are kept unobstructed and not used for stockpiling or storage of materials, equipment, garbage, or Contractor's vehicles and parking.

.2 Construction Traffic Crossing and Entering Public Roads

.1 The Contractor shall limit their construction traffic crossing or entering public roads to as few locations as possible. Crossing and entrance locations shall be provided to the Contract Administrator for review and approval prior to construction starting.

.2 Where construction traffic crosses or enters onto public roads and right-of-ways the Contractor shall obtain the necessary approvals and provide signing and temporary traffic controls detailed in the Workzone Signing Procedures for Utility Operations (Revised June 1999) from the Manitoba Transportation and Government Services.

.2 Site Drainage

.1 Provision of adequate Site drainage during the Work shall be the Contractor's responsibility. No extra payments or time extensions will be granted as a result of difficulties associated with Site access resulting from poor Site drainage during any part of the Work.

.2 Any areas requiring clearing and grubbing to maintain adequate Site drainage shall be reviewed with the Contract Administrator prior to commencement of the Work.

.3 Demobilization and Site Restoration

.1 Further to GC:6.29, the Contractor shall demobilize, clean up, and remove all repair Work related surplus materials, tools, equipment, waste and debris, access roads, storage areas, turnarounds, approaches to public roads, ditch crossings, and temporary culverts and dispose off-site and backfill excavations by the day set for Substantial Performance.

.2 The Contractor shall at their own expense, restore all surface areas damaged or disturbed by their activities at or adjacent to the Site to a condition equal to or better than was existing.

.4 Restricted Access Areas

.1 Refer to the Site plan for area identified as restricted access. No admittance to this area by the Contractor or Contractor's personnel without the Contract Administrator's permission.

7. ENVIRONMENTAL PROTECTION

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

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

.1 Federal

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

.2 Transportation of Dangerous Goods Act and Regulations c.34.

.2 Provincial

.1 The Dangerous Goods Handling and Transportation Act D12.

.2 The Endangered Species Act E111.

.3 The Environment Act c.E125.

.4 The Fire Prevention Act F80.

.5 The Manitoba Nuisance Act N120.

.6 The Public Health Act c.P210.

.7 The Workplace Safety and Health Act W120.

.8 And current applicable associated regulations.

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

.1 Materials Handling and Storage

.1 The Contractor shall abide by the requirements of Manitoba Conservation for handling and storage of fuel Products.

.2 All fuel handling and storage facilities shall comply with the Dangerous Goods and Transportation Act, Storage and Handling of Petroleum Products Regulation and any local land use permits.

.2 Fuel Handling and Storage

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

.2 The Contractor shall ensure that all fuel storage containers are inspected daily for leaks and spillage. Damaged or leaking fuel storage containers shall be promptly removed from the Site.

.3 When servicing requires the drainage or pumping of fuels, lubricating oils or other fluids from equipment, a groundsheet of suitable material (such as HDPE) and size shall be spread on the ground to catch the fluid in the event of a leak or spill. This groundsheet may be supplemented with absorbent fabric material.

.4 Refuelling of mobile equipment and vehicles shall take place at least 100 m from a water reservoir shoreline.

.5 The areas around storage Sites and fuel lines shall be distinctly marked and kept clear of snow and debris to allow for routine inspection and leak detection.

.6 A sufficient supply of materials, such as absorbent material and plastic oil booms, to clean up minor spills shall be stored nearby on-site. The Contractor shall ensure that additional material can be made available on short notice.

.3 Waste Handling and Disposal

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

.2 At no time during construction shall personal or construction waste be permitted to accumulate for more than one (1) day at any location on the construction Site, other than at a dedicated storage area as may be acceptable to the Contract Administrator.

.3 Indiscriminate dumping, littering, or abandonment shall not take place.

.4 No on-site burning of waste is permitted.

.5 The Contractor shall provide waste collection bins within the laydown area acceptable to the Contract Administrator.

.4 Dangerous Goods/Hazardous Waste Handling and Disposal

.1 Dangerous goods/hazardous waste is identified by, and shall be handled according to the Dangerous Goods Handling and Transportation Act and Regulations.

.2 The Contractor shall be familiar with the Dangerous Goods Handling and Transportation Act and Regulations.

.5 Emergency Spill Response

.1 The Contractor shall ensure that due care and caution is taken to prevent spills.

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

.3 The Contractor shall designate a qualified supervisor as the on-site emergency response coordinator for the project. The emergency response coordinator shall have the authority to redirect manpower in order to respond in the event of a spill.

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

.5 Notify emergency response coordinator of the accident:

.1 Identify exact location and time of accident.

.2 Indicate injuries, if any.

.3 Request assistance as required by magnitude of accident (Manitoba Conservation 24-hour Spill Response Line (204) 945-4555, Police, Fire Department, Ambulance, company back-up).

.6 Assess situation and gather information on the status of the situation, noting:

.1 Personnel on-site.

.2 Cause and effect of spill.

.3 Estimated extent of damage.

.4 Amount and type of material involved.

.5 Proximity to waterways and the reservoirs.

.7 If safe to do so, try to stop the dispersion or flow of spill material:

.1 Approach from upwind.

.2 Stop or reduce leak if safe to do so.

.3 Dike spill material with dry, inert absorbent material or dry clay soil or sand.

.4 Prevent spill material from entering waterways and utilities by diking.

.5 Prevent spill material from entering manholes and other openings by covering with rubber spill mats or diking.

.8 Resume any effective action to contain, clean up, or stop the flow of the spilled Product.

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

END OF SECTION

REGULATORY REQUIREMENTS

1. PERMITS/INSPECTIONS

.1 The Contractor shall obtain and pay for all permits, licences, certificates, and governmental inspections required for the performance of the Work.

.2 Give all required notices and comply with all local, provincial and federal laws, ordinances, rules, regulations, codes, and orders relating to the Work, which are or become in force during the performance of the Work.

.3 The Contractor shall make application, obtain and pay for all development permits required for the project, and shall make application, obtain and pay for all relevant permits.

2. APPLICABLE CODES/STANDARDS

.1 The applicable codes/standards for the performance of Work are generally indicated in this Specification.

.2 Where specified codes/standards are not dated, conform to the latest issue of specified codes/standards as amended and revised to the Tender closing date.

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

.4 In the event of discrepancies between codes, standards, and other provisions, the most stringent shall apply.

3. SAFETY

3.1 General

.1 The Contractor shall indemnify the City for any and all additional costs, claims, damages, including claims made by Third Parties, incurred or suffered by the City arising from the breach of Section 3 hereof by the Contractor.

.2 Contractor must be registered and certified under the Manitoba Construction Safety Association's Certificate of Recognition (COR). Bidders may be required to provide evidence of registration and certification.

.3 In case of an emergency the Contractor shall immediately contact the McPhillips Control Center at 204-986-4781 or the shift operator at 204-794-4468.

.4 Observe and enforce all construction safety measures required by code, Workers' Compensation Board, Manitoba Workplace Health and Safety, and all applicable statutes. Appoint a suitably qualified employee who has sole responsibility on-site on behalf of the

Contractor, for compliance with the requirements and so advise the City in writing with copy to the Contract Administrator. The Contractor shall follow safe working practices.

.5 In the event of discrepancies between such provisions, the most stringent provision shall apply.

.6 Employ a qualified Professional Engineer, registered in the Province of Manitoba, for the design of all shoring and falsework for the temporary supports of all structural elements.

.7 Employ employees, agents, and subcontractors who are properly qualified and skilled to do the Work.

.8 Provide ongoing training in safe working practices and safety manuals for its employees, agents and subcontractors.

.9 Use safe tools and equipment.

.10 Obtain all permits, licenses, and clearances.

.1 Establish compliance procedures and take all other necessary measures to protect the safety of works and all other persons who may be in the vicinity of the work Site.

.11 Hard hats and safety boots are mandatory requirements for all workers while on-site. Make available four (4) "VISITOR" safety helmets for authorized visitors.

.12 "NO SMOKING" regulations are in effect in all areas of the Work, ensure that all workers comply with the regulations.

.13 Ensure that all workers comply with the City's safety regulations where such regulations are in effect.

.14 Do not load or permit to be loaded any part of the Work with a weight, load or force that will exceed the design load and/or endanger its safety.

3.2 Safety Measures and Services

.1 The Contractor shall be responsible for the safety of all his employees and other persons entering the Site and shall take all measures necessary to ensure their safety. In particular such measures shall include but shall not be limited to the following:

.1 Observation and provision of proper safety and emergency regulations, fire, gas, and electric shock precautions, stretchers, and a first aid box generally for each place of work.

.2 Safe storage, handling and use of explosives, gases, fuels, and other dangerous goods.

.3 Provision of approved safety helmets for all personnel including authorized visitors to the Site.

.4 Control of water, including the provision of standby pumping and generating plant where necessary.

.5 Provision of lighting to provide adequate illumination of Work, including spares and standby equipment.

.6 Provision and maintenance of safe, sound mechanical cranes, hoists, and conveying facilities for the transport of materials and personnel, each item of plant having an up to date test certificate. All cranes, hoists, and the like shall be fitted with audible overload warning devices.

.7 Provision and maintenance of safe, sound ropes, slings, blocks, and other lifting tackle, each appliance having an up to date test certificate.

.8 Provision of competent operators for control of all lifting and hoisting equipment, with operating personnel.

.9 Provision and maintenance of all temporary electrical installations.

.10 The Contractor shall provide and securely fix into position temporary timber covers not less than 50 mm thick to all openings in floors and roofs.

.11 Provision and maintenance of all welding equipment and concrete cutting/coring equipment.

.12 All equipment to be used by qualified, trained personnel.

.13 Provision of adequate ventilation and testing of air quality prior to and while working in all indoor or enclosed locations. Equipment for continuous monitoring of gases must be explosion-proof and equipped with a visible and audible alarm. The conditions that must be monitored include oxygen deficiency, explosive and toxic gases. The ventilation equipment must work continuously.

.2 The Contractor shall allow the City timely and complete access to the Contractor's records and documentation, to allow the City to confirm the Contractor's ongoing compliance with the safety requirements in the Specification. At all times, the Contractor shall, at the City's request, provide copies of documentation related to safety at no extra cost to the City, including without limitation, copies of:

.1 Resumes, licenses, certification papers, and like documentation for employees of the Contractor, its agents and subcontractors engaged in the Work.

.2 Specifications, permits, test results and licenses, for all equipment to be used in the Work.

.3 All other permits and licenses for the Work.

.3 At all times, the City may inspect and test the equipment to be used in the Work.

.4 The Contractor shall maintain a Workplace Hazardous Materials Information System (WHMIS) file for all hazardous materials used at each work Site. Prior to commencement of the Work, the Contractor shall submit Material Safety Data Sheets (MSDS) to the City for all hazardous materials at work Site. Material brought to a work Site without prior submission of a MSDS shall not be used in the Work.

.5 The Contractor shall comply with the requirements of the Manitoba Labour Guidelines for Confined Entry Work, and the Manitoba Labour Fall Protection Guideline.

.6 If deemed necessary, the Contractor may be required to submit a Safety Mitigation Plan for approval by the City.

3.3 Noise Control On-Site

.1 All plant and equipment supplied by the Contractor for use on the Work shall be effectively "sound-reduced" by means of silencers, mufflers, acoustic linings or shields or acoustic sheds or screens to a level of 85 decibels (dBA) measured outside the nearest occupied property or to the satisfaction of the Contract Administrator.

.2 Provided that the provisions of this clause shall not be applicable in the case of emergency work necessary for the saving of life, property, or for the safety of the Work.

4. CLEANING OF STREETS

.1 Conform to local ordinances and by-laws relating to littering of streets.

.2 Take precautions to prevent depositing mud or debris on public or private roadways adjacent to the Work. Clean up immediately, otherwise the Contract Administrator will direct necessary cleanup with all costs back charged to the Contractor.

5. WORKING LIMITS

.1 Confine all operations within the City's property limits and within the general area of the Work and away from any restricted access zones as identified on the Site plan. Keep existing roadways and access routes open to regular vehicular and pedestrian traffic throughout the duration of the construction.

6. EXISTING UTILITIES

.1 Conform to Provincial and municipal regulations during construction in proximity to utility structures.

.2 Notify appropriate utility companies and municipal departments a minimum one (1) week in advance of commencing such work.

.3 Make arrangements with utility companies and municipal department for protection of pipelines, conduits, drainlines, wiring and other structures, whether underground, on the

surface or overhead, and satisfy the company or department that the methods or operations are effective.

.4 Indemnify and save harmless the City from any loss or damage which may be resulted from the damage of these existing utilities by reason of the operations of the Contractor.

END OF SECTION

PROJECT MEETINGS

1. MEETINGS

1.1 Preconstruction Meeting

.1 Within fifteen (15) days after award of Contract, the Contract Administrator will request a project meeting of parties in Contract to discuss and resolve administrative procedures and responsibilities.

.2 Representatives of the City, Contract Administrator, Contractor, and Major Subcontractors must be in attendance.

.3 Representatives of the Contractor and Subcontractors attending the preconstruction meeting must be qualified and authorized to act on behalf of the party each represents.

.4 After the time and location of this meeting has been established, the Contractor shall notify all parties concerned a minimum of ten (10) days before the meeting.

.5 The Contract Administrator will arrange space and facilities for this meeting.

.6 The Contract Administrator will chair and record discussions and decisions, and circulate the meeting notes to all parties concerned.

.7 Agenda to include the following:

.1 Appointment and notification of official representatives of participants in the Work.

.2 Schedule of the Work, progress scheduling.

.3 Schedule of Shop Drawing submissions.

.4 Schedule for the procurement and delivery of specified equipment.

.5 Plant orientation program.

.6 Requirements for temporary facilities, Site signs, offices, storage sheds, utilities, hoarding, Site access, and use.

.7 Site security.

.8 Health and Safety issues.

.9 Modification procedures, Contemplated Change Notices and Change Order procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements (GC) as originated by the City or in the case of a savings, by the Contractor.

.10 Product and tool storage.

.11 Weather protection.

.12 Record drawings.

.13 Operation and maintenance (O&M) manuals.

.14 Commissioning, acceptance, and handover.

.15 Warrantees.

.16 Monthly progress claims, administrative procedures, photographs, holdbacks (GC).

.17 Appointment of inspection and testing agencies or firms.

.18 Insurances and transcript of policies.

.19 Communications routing and logistics.

.20 Access to the Site and Work areas (security).

.21 Survey.

.22 A schedule for progress meetings.

.23 Emergency telephone numbers.

.24 Other items as arise at the meeting.

1.2 Progress Meetings

.1 Contractor shall schedule and administer progress meetings once a week during construction and through the Commissioning Period.

.2 Provide input to the Contract Administrator for the meeting agenda.

.3 Representatives of the City, Contract Administrator, Contractor, and Major Subcontractors must be in attendance. Arrange for the attendance of other Subcontractors and Suppliers as necessary to address issues on the agenda.

.4 Representatives of the Contractor, Subcontractors, and Suppliers attending meetings must be qualified and authorized to act on behalf of the party each represents.

.5 Agenda for Construction Progress Meetings to include the following:

.1 Review and approval of minutes of previous meeting.

.2 Field observations, problems, conflicts.

.3 Review submittal schedules: Expedite as required.

.4 Review of off-site fabrication and delivery schedule.

.5 Progress, schedule, during succeeding Work period.

.6 Problems, which impede construction schedule.

.7 Corrective measures and procedures to regain projected schedule.

.8 Revisions to construction schedule.

.9 Site coordination review.

.10 Maintenance of quality standards.

.11 Review of Site cleanliness.

.12 Review of Site safety and security.

.13 Review of temporary facilities.

.14 Review requests for information.

.15 Review of Contemplated Change Notices (CNN), Field Orders (FO), Change Orders (CO), and Field Instructions (FI).

.16 Review proposed changes for effect on construction schedule and on completion date.

.17 Review of progress payments.

.18 Outstanding action items.

.19 Date and location of next meeting.

.20 Other business.

.6 The Contract Administrator will preside at the meetings.

.7 The Contract Administrator will record notes of the project meetings, including significant proceedings, decisions, “Action By" parties, dates for completion of duties, etc.

.8 The Contract Administrator reserves the right to cancel any progress meeting or call additional meetings whenever he deems necessary.

1.3 Special Meetings

.1 Special meetings may be requested by the City, Contract Administrator, or Contractor to discuss specific issues. Generally, three (3) days notice is required for special meetings. The agenda will be fashioned to suit the meeting. Minutes will be kept by the Contract Administrator.

END OF SECTION

CITY SUPPLIED EQUIPMENT

1. GENERAL

.1 The City of Winnipeg (City) will be entering into two (2) Equipment Supply Contracts based on the Bid Opportunities described in Section 01010 "Summary of Work". Copies of these Bid Opportunities will be available for viewing at the offices of Earth Tech (Canada) Inc., 850 Pembina Highway, Winnipeg, Manitoba. The details of the equipment will be shown on the Shop Drawings supplied by these Contractors.

.2 The equipment supplied under both of these Bid Opportunities will be delivered to, off-loaded and stored at the City's North End Water Pollution Control Centre (NEWPCC). It is the Contractor's responsibility to pick-up and deliver the equipment to the construction Site for installation and pay all costs for transportation of equipment from the City's storage area.

.3 All forms referred to in this Section (Form 200, 201, 202 and 203) are part of the Supply Contracts and will be provided by the Suppliers to the Contractor to be completed by the Contractor as detailed below.

.4 Prior to accepting any of the equipment to be supplied under the supply contracts, the Contractor shall inspect the equipment. A representative from each of the following groups will be in attendance at the time of pick-up and delivery: the Supplier, Contractor, and Contract Administrator. A duly executed *Form 200 – Certificate of Equipment Delivery* shall be completed. Any minor damage identified during the inspection shall be repaired as per the Manufacturer's recommendations by the Contractor at no cost to the City. Any severe damage will be grounds for rejection of the equipment. The severely damaged equipment will be replaced at no cost to the City. The Contractor shall accept the equipment and assume risk and responsibility for the equipment and fill out *Form 200 - Certificate of Equipment Delivery.* If the Contractor's inspection reveals any deficiencies in the equipment, then these shall be noted in writing prior to the Contractor accepting the equipment. Only deficiencies noted and documented in the foregoing manner will be deemed not the responsibility of the Contractor.

.5 The Contractor shall be responsible for the installation of the equipment to be supplied under the supply contracts in addition to this Contract. The installation shall be in accordance with the Manufacturers' installation requirements.

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

.1 For the equipment supplied under the supply contracts and this Contract, each Supplier shall provide the services of a qualified representative to supervise the installation, start-up, commissioning, and performance testing of all of the equipment. The services to be performed by the Supplier are as follows:

.1 Prior to the Contractor beginning the installation, the Supplier shall provide to the Contractor instructions and advice regarding the detailed requirements for the

equipment installation. The Supplier will be required to provide a *Certificate of Readiness to Install, Form 201*. The Contractor shall be required to sign Form 201 to acknowledge that he has received adequate instruction.

.2 Following the completion of the installation, the Supplier shall inspect the installation of the equipment to verify that it has been installed in accordance with the manufacturer's requirements. The Supplier will be required to provide a *Certificate of Satisfactory Installation, Form 202*. If any deficiencies in the installation exist at the time of inspection, these shall be noted on Form 202 by the Supplier. The Contractor shall be responsible for the prompt correction of these deficiencies prior to the start-up of the equipment.

.3 The Supplier shall supervise and direct the Contractor in starting-up and commissioning the equipment. Commissioning is to conform to the requirements in Section 01670 and Divisions 11, 15, 16, and 17.

.4 Following a period of seven (7) consecutive days of operation of the equipment, the Supplier will be required to complete a *Certificate of Equipment Satisfactory Performance, Form 203*. The Contractor shall sign the form. During the seven (7) day period, the equipment shall be maintained by the Contractor.

.5 The Suppliers from the Equipment Supply Contracts have been contracted to provide Site visits for inspection of installation and for supervision of start-up and commissioning.

.6 The Contractor shall be responsible for supervising and coordinating the services to be provided by the Supplier. The Contractor shall provide to the Supplier and the Contract Administrator, at least fourteen (14) days advance notice of when the Supplier's services will be required.

END OF SECTION

SUBMITTALS

1. SHOP DRAWINGS AND PRODUCT DATA

.1 "Shop Drawings" mean custom Drawings, Product data, diagrams, illustrations, schedules, performance charts, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

.2 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 in writing of any deviations in Shop Drawings from the requirements of the Contract Documents.

.3 Shop Drawings shall be submitted with a copy of the associated Specification. For each Specification clause, note compliance or deviation from Specification. Provide full explanation for any deviation. Shop Drawings submitted without the associated Specification Sections will be returned to the Contractor as “Rejected”.

.4 Examine all Shop Drawings prior to submission to the Contract Administrator to ensure that all necessary requirements have been determined and verified and that each Shop Drawing has been checked and coordinated with the requirements of the Work and the Contract Documents. Examination of each Shop Drawing shall be indicated by stamp, date and signature of a responsible person of the Subcontractor for supplied items and of the General Contractor for fabricated items. Shop Drawings not stamped, signed and dated will be returned without being reviewed and stamped Re-submit".

.5 Submit Shop Drawings with reasonable promptness and in an orderly sequence so as to cause no delay in the Work. Failure to submit Shop Drawings in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of Shop Drawings.

.6 The Contract Administrator will review and return Shop Drawings in accordance with the schedule agreed upon or otherwise with reasonable promptness so as to cause no delay in the Work.

.7 Submit six (6) copies of white prints, plus one (1) copy of reproducibles, and six (6) copies of all fixture cuts and brochures.

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

.9 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.

.10 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation and coordination of all parts of the Work rests with the Contractor.

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

- When stamped "REVIEWED" or "NO EXCEPTIONS TAKEN", distribute additional copies as required for execution of the Work.

- When stamped "REVIEWED AS MODIFIED" or "MAKE NOTED CORRECTIONS", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".

- When stamped "REVISE & RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.

- When stamped "NOT REVIEWED" or "REJECTED", submit other Drawings, brochures, etc. for review consistent with the Contract Documents.

- Only Shop Drawings bearing "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS", or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.

.12 After submittals are stamped "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.

.13 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.

.14 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.

.15 Shop Drawings indicating design requirements not included in the Contract Documents require the seal of a qualified Professional Engineer, registered in the province of the place of the Project. Consulting calculations shall be submitted for review, if requested, and sealed by a qualified Professional Engineer.

.16 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator’s scheduled rates. The Contract Administrator’s charges for the additional Work will be deducted from the Contractor’s Progress Certificates.

2. SAMPLES

.1 Submit samples for the Contract Administrator's review as specified or as the Contract Administrator may reasonably request. Clearly label samples as to origin and intended use in the Work. Reference samples to Drawings and Specifications.

.2 Submit samples with reasonable promptness and in orderly sequence so as to cause no delay in the Work. Failure to submit samples in ample time is not to be considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed. Jointly prepare a schedule fixing the dates for submission and return of samples (refer to Section 01200 – Project Meetings).

.3 Notify the Contract Administrator in writing, at the time of submission, of any deviations in samples from requirements of Contract Documents.

.4 The Contract Administrator's review will be for conformity of design concept and general arrangement only. Such review is not to be considered relief of responsibility for errors or omissions in samples or of responsibility for meeting all requirements of the Contract Documents.

.5 Any adjustments made on samples 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 the Work.

.6 Make changes in samples, which the Contract Administrator may require, consistent with Contract Documents.

3. OPERATING/MAINTENANCE MANUALS

.1 For the guidance of the City's operating and maintenance (O&M) personnel, the Contractor shall prepare operation and maintenance manuals for the Work, describing in detail the construction of each part of the Work and the recommended procedure for operation, servicing and maintenance.

.2 Three (3) advance copies of the manuals shall be submitted prior to Substantial Performance of the Work and shipment for review and comments. A minimum of eight (8) weeks after review, six (6) copies of the final manuals shall be supplied. Each copy shall be clearly titled to show all of the information required by the Specifications as well as operational information including: the item of Work concerned, a City's contract number, the name and address of the Contractor, the issue date, operational information on equipment, cleaning and lubrication schedules, filters, overhaul and adjustment schedules.

.3 All instructions in these manuals shall be in simple language to guide the City in the proper O&M of this installation.

.4 Submit O&M Manuals in electronic format Organize contents into applicable sections of Work, parallel to Specifications break-down.

.5 In addition to information called for in the specifications, include the following:

.1 Title sheet, labeled "Operation and Maintenance Instructions", and containing project name and date.

.2 List of contents.

.1 Brochures/catalogue excerpts of all architectural, mechanical and electrical components of the Work.

.2 Documentation of all test results.

.3 Complete set of equipment and assembly Drawings.

.4 Installation, start-up, O&M manuals.

.5 Commissioning data sheets and reports.

.6 Air Balancing Reports.

.7 Spare parts lists/priced, and special tools requirements/priced.

.8 Any specific Product or maintenance manual requirements from the Technical Specifications.

.3 Reviewed Shop Drawings of all equipment.

.4 As-built Drawings of all mechanical and electrical/Instrumentation & Controls (I&C) installations.

.5 Full description of entire mechanical system and operation.

.6 Names, addresses and telephone numbers of all major Subcontractors and Suppliers.

.7 Detailed O&M instructions for all items of equipment, including a preventative maintenance program.

.6 The Contractor shall modify and supplement the manual as required by the Contract Administrator.

.7 Provide list of spare parts and consumables, including name and address of nearest Supplier.

.8 The O&M Manuals shall be supplied to the City before delivery and provision shall be made for additions and deletions, which may be dictated by the City’s operational experience. Where these amendments to the manuals are indicated to be necessary during initial operation before acceptance, the Contractor shall supply the amended Sections free of charge.

.9 Payment for this Item of the Work, as listed in Form B: Prices, will not be issued until all requirements for the O&M manuals have been satisfied.

4. RECORD DRAWINGS

.1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining Project Record Drawings, electronic files in AutoCAD format will be supplied. Accurately record significant deviations from Contract Documents caused by Site conditions and changes ordered by the Contract Administrator. Update daily.

.2 Record locations of concealed elements of mechanical and electrical services.

.3 Identify Drawings as "Project Record Copy". Maintain in good condition and make available for inspection on-site by Contract Administrator at all times.

.4 On completion of the Work, two (2) weeks prior to final inspection, submit Record Drawings to Contract Administrator for review.

.5 Within one (1) month after return of Record Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from Record Drawings to electronic Drawings (AutoCAD) and certify accuracy. Deliver electronic Drawings to the Contract Administrator.

5. PHOTOGRAPHS AND PUBLICITY

.1 No photographs of the Site or of any portion of the Work will be permitted without prior approval of the Contract Administrator.

.2 No press or publicity releases will be permitted without prior approval of the Contract Administrator.

6. PROCEDURES

.1 The Contractor shall, if required by the Contract Administrator, submit for the review of the Contract Administrator method statements which describe in detail, supplement with Drawings where necessary, the methods to be adopted for executing any portion of Work.

.2 These statements shall also include details of constructional plant and labour to be employed. Acceptance by the Contract Administrator shall not relieve the Contractor of any of his responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.

END OF SECTION

QUALITY ASSURANCE

1. INSPECTION AND TESTING OF WORK

1.1 General

.1 The City of Winnipeg (City), the Contract Administrator, and other authorities having jurisdiction shall have access to the Work. If parts of the Work are in preparation at locations other than the Place of the Work, access shall be given to such Work whenever it is in progress.

1.2 Laboratories/Agencies

.1 Independent Inspection/Testing Agencies may be engaged by the City for the purpose of inspecting and/or testing portions of the Work. All costs of such services will be borne by the City. Any additional tests required due to defective Work shall be paid by the Contractor.

.2 All equipment required for carrying out inspection and/or testing will be provided by the respective Agencies.

.3 Employment of Inspection/Testing Agencies in no way relieves the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

.4 Allow the Inspection/Testing Agencies access to all portions of the Work on-site and manufacturing or fabrication plants, as may be necessary. Provide facilities for such access.

1.3 Design Standards, Code Requirements

.1 Inspection and/or testing will be performed in accordance with, but not limited to, the following:

.1 Concrete to Canadian Standards Association (CSA) A23.2 and mix designs to CSA-A23.1.

.2 Welding to CSA W59.1 and American Society for Testing and Materials (ASTM) E109.

.3 Bolted connections to CSA S16 or S16.1.

.4 Roofing to CRCA manual.

1.4 Tests and Mix Design

.1 Prior to commencement of the Work, submit to the Contract Administrator and Inspection/Testing Agency, the following:

.1 Test results and mix designs of each class of concrete.

.2 Mill test certificates for all structural steel and bolts.

2. PROCEDURES

.1 Notify the Contract Administrator well in advance of the requirements for tests in order that necessary arrangements can be made.

.2 Submit samples and/or materials required for testing with reasonable promptness so as to cause no delay in the Work.

.3 Provide facilities to allow inspection and/or testing and make available space for storage and curing of the test samples.

.4 If defects are revealed during inspection and/or testing, then the Contract Administrator may issue instructions for removal or correcting defective work and irregularities. The Contractor shall notify the Contract Administrator within two (2) working days if such instructions are in error or at variance with the Contract Documents.

.5 Costs for re-inspection and/or testing of rejected Work shall be borne by the Contractor.

3. REFERENCE STANDARDS

.1 Within the text of the specifications reference may be made to the following standards:

ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CCA	Canadian Construction Association
CEC	Canadian Electrical Code (published by CSA)
CEMA	Canadian Electrical Manufacturers Association
CGSB	Canadian Government Specification Board
CISC	Canadian Institute of Steel Construction
CLA	Canadian Lumberman's Association
CPCA	Canadian Painting Contractors Association
CPCI	Canadian Prestressed Concrete Institute
CRCA	Canadian Roofing Construction Association
CSA	Canadian Standards Association
FM	Factory Mutual Engineering Corporation
IEEE	Institute of Electrical and Electronic Engineers
IPCEA	Insulated Power Cable Engineers Association
NAAMM	National Association of Architectural Metal Manufacturers
NBC	National Building Code
NEMA	National Electrical Manufacturers Association
TTMAC	Terrazzo, Tile and Marble Association of Canada
ULC	Underwriters Laboratories of Canada

Conform to such standards, in whole or in part, as specified.

.2 If there is question as to whether any Product or system is in conformance with applicable standards, the Contract Administrator reserves the right to have such Products or systems tested to prove or disprove conformance. The cost for such testing will be borne by the City in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.

.3 Where specified standards are not dated, conform to latest issue of specified standards as amended and revised to the Tender closing date.

END OF SECTION

1. FIELD OFFICES AND SHEDS

1.1 Contractor's Office

.1 Accommodation for the Contractor's office, plant, tools, equipment, and materials (including fuel) shall be the responsibility of the Contractor. Such accommodation at the Site shall be located after consultation with the City. The Contractor shall be responsible for the protection of its plant, tools, equipment, and materials stored on-site. Materials stored on the City's premises shall be neatly stacked and protected from the weather.

.2 Provide and maintain in clean condition during entire progress of the Work, a suitable office adequately lighted, heated and ventilated, for own use.

.3 Locate where directed by Contract Administrator in area shown on the Site plan.

.4 Provide within office space adequate first aid facilities as recommended by the Ministry of Labour and Worker's Compensation regulations.

.5 The Contractor shall further confine their activities to the minimum area necessary for undertaking and completing the Work. Material and equipment storage areas shall be at locations acceptable to the Contract Administrator.

.6 The Contractor's construction activities shall not encroach or enter onto private property without written consent from the owner of the property concerned. The Contractor shall provide the Contract Administrator with a copy of the written agreement with the property owner.

.7 Subcontractors are to provide their own offices as necessary, as directed by the Contract Administrator.

1.2 Contract Administrator's Office

.1 Provide and maintain in a clean condition, during the entire progress of the Work, three (3) lockable offices, and one (1) multi-purpose space for conducting meeting general progress meetings. These spaces shall be adequately lighted, heated, and ventilated, for use by the Contract Administrator or designate. The general meeting room shall be sized to suit the requirements of the regular progress meetings.

.2 Locate where directed by the Contract Administrator in area shown on-site plan.

.3 Provide within office space adequate first aid facilities as recommended by the Ministry of Labour and Worker's Compensation regulations.

.4 The offices are to be a minimum of 20 sq. m. each with a minimum of 2.4 m headroom, and a minimum of two (2) 900 mm x 1,200 mm sized opening sash windows per office.

.5 Furnish each office with a drawing layout table, desk, chair, and lockable file cabinet with minimum dimensions of 1,800 mm high x 300 mm wide by 450 deep.

.6 Furnish the general meeting room with table and chairs adequate to accommodate the progress meetings.

.7 All finishes including walls, ceilings, and floors to be finished in a manner acceptable to the Contract Administrator.

.8 The Contractor shall supply and maintain the toilet and washroom in the Contract Administrator's trailer adjacent but separate from the office and meeting room spaces. The toilet and washroom shall comply with the requirements of The Public Health Act, R.S.M. 1987, c. P210, including sewage holding facilities and water storage. Sewage connections are not available.

.9 Provide and pay for all heating, lighting, telephone, and communications services.

1.3 Laydown and Storage

.1 All construction materials shall be stored at designated Site laydown and storage areas. Stored combustible materials shall be separated by clear space to prevent fire spread and allow access for manual fire fighting equipment, including fire hoses, extinguishers, hydrants, etc.

.2 Designated areas shall be used for storage of flammable and combustible liquids and gases, which shall be properly equipped for grounding and bonding when refueling vehicles and equipment. Spills shall be contained as required by Provincial Regulations.

.3 Pressurized dry chemical fire extinguishers of suitable capacity or equally effective extinguishers as per National Fire Protection Association (NFPA) 10 shall be provided where:

.1 Flammable liquids are stored or handled.

.2 Temporary oil or gas fire equipment is used.

.3 Welding or flame cutting is performed.

1.4 Temporary Construction Materials

.1 Tarpaulins and plastic coverings shall consist of fire retardant materials, which are Underwriter's Laboratories Inc. (UL) or FM listed and/or approved, or which have passed the Large Scale Test specified in NFPA-701.

1.5 Contractor's Trailers

.1 The Contractor shall provide construction power at 120/240 V, 1 Ø, and 600 V, 3 Ø to the service points designated at the Work Site and to the Contractor's and Contract Administrator's temporary Site office trailers.

.2 The Contractor shall, at its own cost, supply, install, maintain, and move extensions to the above services as required during the Construction Period, subject to Canadian Standards

Association (CSA) Standard C22.1 latest edition and Manitoba Hydro Standards and approval.

.3 The Contractor shall:

.1 Prevent hazardous accumulations of dust, fumes, mist, vapours, or gases in areas occupied during construction.

.2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.

.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.

.4 Ventilate storage spaces containing hazardous or volatile materials.

.5 Ventilate temporary sanitary facilities.

.6 Continue operation of ventilation and exhaust system for time after cessation of Work process to assure removal of harmful elements.

.4 Suitable fire control equipment shall be provided by the Contractor for protection of its facilities, the portion of the City's building under construction and materials and equipment at all Work areas. All fire protection equipment and fuel storage shall meet the approval of the Contract Administrator. Storage of fuel will not be permitted in the vicinity of the Work.

.5 Unless approved by the City, burning of any materials is **NOT** allowed at the Site of the Work.

.6 The Contractor shall be responsible for any damage resulting from fires caused by the Contractor or its employees and shall be solely responsible for all costs, which may be incurred in extinguishing such fires.

1.6 Toilets and Washrooms

.1 Washroom facilities are not available at the North End Water Pollution Control Centre (NEWPCC) for the Contractor's use.

.2 The Contractor shall supply and maintain all necessary toilets and washrooms for its employees engaged in the Work. These toilets and washrooms shall comply with the requirements of The Public Health Act, R.S.M. 1987, c. P210, including sewage holding facilities and water storage. Sewage connections are not available.

1.7 Disposal of Waste Materials

.1 Spoiled and/or waste materials shall not be dumped, under any circumstances, in any locations other than those approved by the local authorities. Any cost for permits and fees for disposing of waste materials shall be at the Contractor's expense.

.2 Disposal of all excavated and waste materials shall be in accordance with the requirements of the appropriate provincial regulatory agencies.

.3 When working anywhere within the Works the Contractor shall at the end of each working day remove his rubbish and leave the Site in a clean and tidy state, to the satisfaction of the Contract Administrator. If this is not done, the City will clean the Site and charge the Contractor.

1.8 Parking

.1 The Contractor shall provide parking in the area designated on the plans for contractor laydown and trailers. The City may designate additional parking areas for the Contractor's vehicles. The parking shall be arranged and maintained so that is does not disrupt the NEWPCC operation and access for the City's Operations and Maintenance (O&M) staff.

.2 The Contractor shall provide appropriate base course material for the laydown, trailer and parking area to allow vehicle traffic and parking. The Contractor shall restore this area to its original state at the completion of construction.

1.9 Contractor's Site Storage for Equipment and Materials

.1 The Contractor shall provide and maintain in a clean and orderly condition an adequately sized storage facility on-site, which will provide weather protected storage for all the tools, equipment, and materials necessary for the undertaking and completion of the Work.

.2 The storage facility shall be located where directed by the Contract Administrator in the area identified on the Site plan.

.3 The storage facility shall be temperature controlled to provide a minimum interior temperature of 10°C, and be large enough to provide access to equipment for periodic maintenance.

.4 The compound shall have a hard base suitable for the storage of heavy equipment. Adequate temporary drainage shall be provided around the facility.

.5 The storage of equipment and materials shall be limited to the storage facility only.

.6 The responsibility for the security of the Site storage and the condition of all the equipment and materials therein shall rest solely with the Contractor.

.7 The Contractor will be responsible for removal of this facility prior to issuance of Total Performance.

1.10 Access to Site Office and Storage Facilities

.1 The Contractor shall provide vehicular accesses to the Site office and storage facilities from the existing access road. The access shall be suitable for use by heavy trucks and shall be

kept in a clean serviceable condition and free of obstructions for as long as these offices and storage facilities are required for use.

.2 The access roads, turnarounds, parking areas and storage areas, shall be left in a rut-free condition.

.3 Any areas requiring clearing and grubbing for the access roads, turnarounds, parking and storage areas, and approaches to public roads shall be reviewed with the Contract Administrator prior to commencement of the Work.

.4 Provide adequate parking for Contract Administrator and designate (minimum two spaces).

2. UTILITIES

2.1 Water Supply

.1 The Contractor is responsible to provide water required for the construction Works and for the water required for water tightness testing identified in Section 03300.

.2 The Contractor shall, at its own cost, supply, install, maintain, and move extensions to water services as required during the Construction Period, subject to the City's approval.

2.2 Heating and Hoarding

.1 The Contractor shall:

.1 Provide all temporary heating required during Construction Period for storage facilities and concrete curing, including attendants, maintenance, and fuel. The Contractor will maintain temperatures of minimum 10°C in the temporary facilities, unless indicated otherwise in Specifications. Properly ventilate all heated areas.

.2 Pay for all costs in maintaining and providing temporary heat to the temporary facilities.

.3 Be responsible for any damages to the Work due to failure in providing adequate heat and protection during construction.

2.3 Power and Light

.1 The Contractor shall:

.1 Provide temporary power and light for own use and for the Contract Administrator's office. Install in accordance with regulations of governing authorities.

.2 Provide and pay for all temporary power required during Construction Period for temporary lighting and the operations, including power required for the Contract Administrator's office.

.3 Wiring for temporary lighting is to be entirely separate from temporary power installation except for a common supply connection at either an electrical service or distribution centre.

2.4 Telephone

.1 The Contractor shall provide for all temporary communications, telephone service including services to the Contract Administrator's offices.

2.5 Use of Permanent Water Supply, Heat, Power Light and Telephone

.1 The Contractor shall not make use of permanent water supply, heat, power, lighting, or telephone inside the NEWPCC without obtaining permission from the Contract Administrator or the City.

2.6 Fueled Welding Machines and Air Compressors

.1 Fueled welding machines and air compressors required for performance of the Work are to be the responsibility of the respective users. Locate outside of building.

3. BARRIERS

3.1 Guard Rails and Barricades

.1 Provide guard railings and barricades, around all openings, open shafts, open stairwells. Construct as recommended by local governing authorities.

4. CONSTRUCTION AIDS

4.1 Scaffolding

.1 Provide and maintain adequate scaffolding as required. Scaffolding is to be rigid, secure, and constructed to ensure adequate safety for workers. Erect without damage to the building or finishes.

4.2 Ladders, Stairs

.1 Provide and maintain adequate temporary ladders and stairs required for construction.

.2 Secure to structure.

.3 Ladders and stairs are to comply with all requirements of safety authority.

.4 Provide temporary wood treads on steel pan stairs for use prior to placement of permanent treads.

4.3 Explosive Actuated Fastening Tools

.1 Provide for the use of explosive actuated fastening tools when required. When using, conform to the requirements of CSA Z166 - "Explosive Actuated Fastening Tools" and local governing authorities.

5. ROADS

5.1 Access To Site

.1 Provide and maintain access roads, sidewalk crossings, ramps, and construction runways as required for access to and on-site. Conform to requirements of local governing authorities when required and when necessary make arrangements with adjacent property owners. Locate these traffic facilities where they are least disruptive to normal street traffic and local on-site traffic.

5.2 Temporary Vehicular and Pedestrian Access

.1 Maintain existing vehicular and pedestrian accesses properly at all times during the Construction Period.

.2 The Contractor shall confine his equipment, storage of materials, and operations of his workmen to minimize Site damage. The Contractor shall be responsible to restore all areas damaged or affected by construction to equal or better conditions, which existed prior to construction, unless designated otherwise.

6. TRAFFIC CONTROL

6.1 Public Traffic Flow

.1 Provide and maintain flag persons, traffic signals, barricades, and flares/lights/lanterns as required to direct the flow of equipment used in performance of the Work and to protect public traffic. Make arrangements with local governing authorities when these facilities will disrupt the normal flow of public traffic.

7. PROTECTION OF WORK AND PROPERTY

7.1 Protection for Off-Site and Public Property

.1 Protect adjacent private and public property from damage during the performance of the Work.

.2 Be responsible for all damages incurred due to improper protection.

7.2 Fire Protection

.1 Provide and maintain adequate temporary fire protection equipment during performance of the Work as required by insurance companies having jurisdiction.

.2 Provide minimum one (1) fire extinguisher in each equipment and tool shed, temporary office, material storage shed workshop.

.3 Where subjected to low temperatures, extinguishers are to be anti-freeze type. In proximity to gas, oil, grease or paint storage locations they are to be #10 - carbon dioxide type. Extinguishers for all other locations are to be soda-acid type. All extinguishers are to be minimum 10 litre capacity and be ULC labelled.

.4 Handle gasoline and like combustible materials with good, safe practice.

.5 Remove combustible debris from Site daily.

7.3 Protection of Building Finishes and Equipment

.1 Provide adequate protection for finished and partially finished building finishes and existing equipment and services during the performance of the Work. Provide necessary screens, covers, hoardings, etc. as required. Be responsible for all damages incurred due to improper or lack of protection.

.2 The Contractor shall use methods of construction on concrete Work that will not generate dust.

.3 The Contractor shall protect existing mechanical and electrical equipment from damage.

.4 Maintain and protect existing services in operation during the course of the Work. Repair services damaged at no cost to the City.

.5 If service interruptions are necessary, such interruptions shall be made only at times approved by the City.

.6 Advise the Contract Administrator of any necessary service relocations not identified by the Contract documents.

7.4 Protection of Trees

.1 Protect trees located on or adjacent to the Site, which may be affected by the Work, from any potential damage which could occur as a result of the construction and related activities.

.2 Site enclosures, fencing, hoarding or other protective walkways, or facilities shall not be secured, braced, or otherwise fastened to trees.

.3 Do not remove trees unless specifically noted on the plans, or as directed and approved by the Contract Administrator.

7.5 Snow Removal

.1 Remove snow and ice from access roads, Contractor parking and laydown areas, office and storage areas. The Contractor shall be responsible for repairing any damage to the access road to, and the parking and storage areas within, the Contractor's Site Laydown area directly attributable to their operation.

.2 Remove snow and ice from building surfaces as necessary for construction.

.3 The City shall be responsible for snow removal and maintaining the existing access road to the NEWPCC Site.

.4 Except where noted otherwise, the Contractor shall be responsible for snow removal and maintaining the access roads, turnarounds, parking areas and storage areas during the course of the Work to facilitate safe access to the Work areas.

8. ACCESS TO SITE AND BUILDING

8.1 Site

.1 Access to the Site will be available from the existing roadways. The locations for vehicular accesses from these roadways are generally as shown on the Drawings.

.2 It will be the Contractor's responsibility to check that these accesses are in suitable condition before any plant, equipment or materials are dispatched to Site.

.3 Access on the Site is restricted by existing buried and surface utilities and structures. Contractor to confirm location of all potential obstructions and to review routing of construction vehicles with the Contract Administrator.

.4 The Contractor is to maintain access at all times for City personnel or the Contract Administrator.

8.2 Building

.1 The NEWPCC is normally manned during the working hours. For security reasons, access beyond the restricted access zone and into the inside of the building is limited to the City's employees and other authorized personnel. Obtain Contract Administrator approval prior to entering this area.

.2 The Contractor shall be required to submit to the Contract Administrator the names of all persons the Contractor wishes to have on the site. The Contract Administrator may reject anyone without explanation.

9. ACCESS TO WORK

.1 Normal working hours for City staff working inside the building shall be the period between 7:30 a.m. and 4:00 p.m., Monday to Friday, except holidays.

.2 The Contract Administrator shall be informed at least 24 hours in advance where the Contractor intends to carry out Work outside Normal Working Hours and no such Work shall be done without the Contract Administrator's approval except when the Work is unavoidable or absolutely necessary for:

.1 Preventing injury to any person or saving the life of any person; or

.2 Preventing damage to property where the circumstances placing the property in danger could not reasonably have been foreseen and where the immediate carrying out of such Work is necessary in order to prevent damage to that property; in which case the Contractor shall immediately advise the Contract Administrator in writing that such Work outside the Normal Working Hours is necessary and of the reasons for this. He shall also state the nature and extent of Work to be carried out.

.3 The Contractor is to co-ordinate activities with City personnel and any other Contractors that may be working concurrently in the pumping station.

.4 The Contractor shall observe all rules and regulations established by the City for the safe operation of the station when working in or moving about any part of the station.

10. SECURITY

10.1 Site Lighting

.1 Provide and pay for temporary Site lighting as required for non-daylight times. Install lamps in suitable locations to obtain unobstructed light over all Work areas.

.2 Perform daily inspection of Site lighting and replace burned out and missing lamps. Relocate promptly any lights that become obstructed by new Work.

11. ENVIRONMENTAL CONTROLS

11.1 Noise Control

.1 Abide by all local ordinances. Adjust hours of operation accordingly.

11.2 Dust Control

.1 Initiate dust control measures to minimize dust generation.

12. PROJECT IDENTIFICATION

12.1 Warnings and Traffic Signs

.1 When Work is performed within public areas, provide and erect adequate warning signage as necessary to give proper warning. Place sign sufficiently in advance to enable public to respond to directions.

.2 Warning and traffic signs shall be illuminating type, visible to public and traffic during day and night time hours.

.3 Provide and maintain signs and other devices required to indicate construction activities or other temporary or unusual conditions resulting from project Work.

END OF SECTION

MATERIAL AND EQUIPMENT

1. PRODUCTS

1.1 Quality of Materials

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

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

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

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

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

1.2 Availability of Materials

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

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

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

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

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

1.3 Storage, Handling and Protection of Materials

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

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

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

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

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

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

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

.8 Remove and replace damaged Products at own expense.

1.4 Manufacturers' Directions

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

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

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

1.5 Transportation Costs of Materials

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

2. WORKMANSHIP

2.1 General Requirements

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

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

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

2.2 Coordination

.1 Coordinate the Work of all Subcontractors.

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

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

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

2.3 Concealment

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

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

2.4 Location of Fixtures

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

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

2.5 Cutting and Remedial Work

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

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

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

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

2.6 Fastenings

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

.2 Prevent electrolytic action between dissimilar metals and materials.

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

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

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

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

2.7 Protection of Work In Progress

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

.2 Prevent overloading of any part of the Work.

2.8 Cleaning

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

3. MEASUREMENT

3.1 Metric Project

.1 Unless otherwise noted, this Project has been designed and is to be constructed in the International System of Units (SI) metric system of measurements.

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

END OF SECTION

EQUIPMENT INSTALLATION

1. INTENT

.1 This Section describes general requirements for all equipment supplied under the Contract relating to the supervision of installation, testing, operation, and performance verification. The Contractor shall be responsible for the installation Work, testing, operation, and performance verification of the supplied equipment.

2. DEFINITIONS

.1 Manufacturer: The Manufacturer is the person, partnership, or corporation responsible for the manufacture and fabrication of equipment provided to the Contractor for the completion of the Work.

.2 Manufacturer's Representative: A Manufacturer's Representative is a trained serviceman empowered by the Manufacturer to provide installation, testing, and commissioning assistance to the Contractor in his performance of these functions.

3. EXPERTISE AND RESPONSIBILITY

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

.2 Should the Contract Administrator issue an Addendum, Field Order (FO), Change Order (CO), 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.

4. EQUIPMENT DELIVERY

.1 The equipment shall be delivered to the North End Water Pollution Control Centre (NEWPCC) construction Site to the Contractor who shall be responsible for taking delivery of the equipment. Written acceptance of receipt, at delivery, by the Contractor shall constitute "Delivery to Site" under this Contract. A representative from each of the following groups will be in attendance at the time of delivery: the Supplier, Contractor, and Contract Administrator. A duly executed "Certificate of Equipment Delivery" (Form 100) shall be completed. Any minor damage identified during the inspection shall be repaired as per the Manufacturer's recommendations by the Contractor at no cost to the City. Any severe damage will be grounds for rejection of the equipment. The severely damaged equipment will be replaced at no cost to the City.

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

.3 The Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the Site.

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

5. INSTALLATION ASSISTANCE

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

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

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

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

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

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

6. INSTALLATION

.1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Contractor 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 Contractor 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 Contractor shall inform the Manufacturer and arrange for the attendance at the Site of the Manufacturer's Representative to verify successful installation.

.4 The Manufacturer’s Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, belt tensions, rotation direction, running

clearances, lubrication, workmanship, and all other items as required to ensure successful operation of the equipment.

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

.6 The deficiencies shall be rectified by the Contractor and the Manufacturer's Representative will be required to re-inspect the installation, at no cost to the City.

.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 by 200 mm card stating "Equipment Checked. Do Not Run." stenciled in large black letters. Sign and date each card.

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

7. OPERATION AND PERFORMANCE VERIFICATION

.1 Equipment will 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 Contractor and the Contract Administrator.

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

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

.5 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 will demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will 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., will 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 will be stopped and critical parameters, such as alignment, will be rechecked.

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

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

.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, chemicals, temporary power, heating, or any other ancillary services required to complete the initial demonstration, running test and performance tests are the responsibility of the Contractor.

.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. Additional costs incurred by the Contractor, the Contract Administrator, or the City, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Contractor.

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

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

CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100

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

PROJECT: _____

ITEM OF EQUIPMENT: _____

_____

TAG NO: _____

REFERENCE SPECIFICATION: _____

_____ _____
(Authorized Signing Representative of the Contractor) Date

_____ _____
(Authorized Signing Representative of the Subcontractor) 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

_____ _____
(Authorized Signing Representative of the Subcontractor) Date

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

_____ _____
(Authorized Signing Representative of the Contractor) 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 Contractor) Date

CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE
FORM 103

We certify that the equipment listed below has been continuously operated for at least three (3) 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 Subcontractor) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

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

1. Acknowledgement of Receipt of O&M Manuals.

_____ _____
(Authorized Signing Representative of the City) Date

END OF SECTION

TRAINING

1. DESCRIPTION

.1 This Section contains requirements for training the City's staff, by persons retained by the Contractor specifically for the purpose, in the proper operation and maintenance (O&M) of the equipment and systems installed under this Contract.

.2 Training sessions are required during the Equipment Performance Testing (EPT).

.3 As a minimum, the Contractor is to allow at least four (4) hours of training per shift, as required for each item of equipment or system. Refer to the equipment Specifications for specific time periods.

.4 The intent is that the City should receive sufficient training on the equipment system that they are going to operate and maintain. The Contract Administrator shall have the authority to determine the duration and content of each training session required.

.5 Training sessions should include a test with a pass fail in terms of continuing education units in the Province of Manitoba

2. QUALITY ASSURANCE

.1 Where required by the equipment Specifications, provide on-the-job training of the City staff. Training sessions will be conducted by qualified, experienced (two (2) years minimum), factory-trained representatives of the various equipment suppliers. Training includes instruction of City staff in equipment operation and preventive maintenance and instruction on mechanics, electricians, instrumentation, and communications technicians in normal maintenance up to major repair.

.2 The trainer(s) proposed by the Contractor shall be experienced in training plant operators and shall have relevant experience in similar work.

3. SUBMITTALS

.1 Submit the following information in accordance with Section 01300. For phased testing and start-up activities, separate submittals can be prepared for equipment items or systems. The material will receive a "REVIEWED" or "REVIEWED AS MODIFIED" status by the Contract Administrator no later than four (4) weeks prior to delivery of the training:

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

.2 Date, time, and subject of each training session.

.3 Training schedule. Concurrent classes will not be allowed.

4. LOCATION

.1 Where specified, conduct training sessions for the City staff, O&M personnel, on the operation, care, and maintenance of the equipment and systems installed under this Contract. Training will take place at the Site of the Work and under the conditions specified in the following paragraphs.

.2 Field training sessions will take place at the site of the equipment. Classroom training to take place in the boardroom in the Administration Building. The Contract Administrator may direct the classroom training to take place at another suitable location.

5. LESSON PLANS

.1 Prepare formal written lesson plans for each training session and coordinate with the Contract Administrator. Lesson plans to contain an outline of the material to be presented along with a description of visual aids to be utilized during the session. Each plan will contain a time allocation for each subject. Furnish ten (10) copies of necessary training manuals, handouts, visual aids, and reference materials at least two (2) weeks prior to each training session.

6. FORMAT AND CONTENT

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

.1 Familiarization

.2 Safety

.3 Operation

.4 Troubleshooting

.5 Preventive maintenance

.6 Corrective maintenance

.7 Parts

.8 Local representatives

7. VIDEO RECORDING

.1 The City may record each training session. After taping, the material may be edited and supplemented with professionally produced graphics to provide a permanent record for the City's use. Advise all suppliers providing training sessions that the training material may be videotaped.

8. TRAINING

8.1 General Requirements

.1 Conduct training in conjunction with the Equipment Performance Testing (EPT) period (see 01650). Schedule classes such that classroom sessions are interspersed with field instruction in logical sequence. Arrange to have the training conducted on consecutive days, with no more than four (4) hours of classes scheduled for any one (1) shift.

.2 Provide final operation and maintenance manuals, as defined in Section 01300, for the specific equipment to the City at least four (4) weeks prior to the start of any training. Videotaping may take place concurrently with all training sessions.

8.2 Operator Classroom Training

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

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

.2 Purpose and plant function of the equipment.

.3 The operating theory of the equipment.

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

.5 Safety items and procedures.

.6 Routine preventive maintenance.

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

.8 Required equipment exercise procedures and intervals.

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

.10 Exam

8.3 Operator Hands-On Training

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

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

.2 Discussing, demonstrating, and performing standard operating procedures and daily visual inspection of system operation.

.3 Discussing and performing the preventive maintenance activities.

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

.5 Performing the required equipment exercise procedures.

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

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

8.4 Maintenance Classroom Training

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

.1 Basic theory of operation.

.2 Description and function of equipment.

.3 Routine start-up and shutdown procedures.

.4 Normal and major repair procedures.

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

.6 Routine and long-term calibration procedures.

.7 Safety procedures.

.8 Preventive maintenance and up to and including major repairs such as replacement of major equipment part(s) with the use of special tools.

.9 Exam

8.5 Maintenance Hands-On Training

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

.1 Locating and identifying equipment components.

.2 Reviewing the equipment function and theory of operation.

.3 Reviewing normal repair procedures.

.4 Performing routine start-up and shutdown procedures.

.5 Reviewing and performing the safety procedures.

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

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

8.6 Equipment and Systems for Training

.1 Provide training during the EPT period for the following equipment and systems:

.1 The Vertical Axial Flow Pumps O&M.

.2 The Variable Frequency Drive (VFD) O&M.

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

8.7 Training Completion Forms and Payment

.1 Training for the Contractor-Supplied equipment shall be conducted before the operation period as described in **Form 103** (included in Section 01650 of this Contract).

.2 Training for the City-Supplied equipment shall be conducted before the operation period as described in **Form 203** (included in Part G of Supply Contracts).

.3 The Contract shall not be considered complete, for the purpose of issuing a Certificate of Substantial Performance, until the training has been provided and **Form 103** or **Form 203,** as applicable, has been completed and signed.

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

.5 Form T2: To be completed for training during the Warranty Period. One (1) form is to be used for each equipment/system for which training has been provided.

.6 Payment for this Work will be released only when the training has been completed to the City's satisfaction and the respective forms are signed.

.7 A sample of Forms T1 and T2 are attached to this Specification Section.

8.8 Training Exams

.1 Provide and mark an exam for each group of City staff that attend the training sessions. Pass mark shall be 70%. The exam can be an open-book exam, if required.

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 City) Date

CERTIFICATE OF SATISFACTORY TRAINING
FORM T2

We certify that the final 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 City) Date

END OF SECTION

1. COMMISSIONING

1.1 General

.1 Equipment furnished under the supply contracts will be commissioned by the Contractor under this Contract. The supplier for the City of Winnipeg (City) supplied equipment contracts will provide the services of a qualified representative to assist in the commissioning and performance testing of all of the equipment. Coordinate Commissioning for the City supplied equipment contracts and integrate with Commissioning of this Contract.

.2 At the time of the Commissioning, the Contract Administrator shall advise the Contractor of the Commissioning requirements. These requirements are dependent on the anticipated operational requirements of the City's water supply system to meet the water demands at the time.

.3 The Contractor shall refer to Divisions 1, 11, 15, 16, and 17 for details on the Commissioning procedures not included in this Section.

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

2. INTENT

.1 This Section describes the Contractor’s responsibilities in the Commissioning and hand over of the process, electrical, and other systems to be installed as part of this Work.

3. DEFINITIONS

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

.2 Commissioning: For the purpose of this Specification Section, Commissioning shall be defined as the successful operation of a system in accordance with its design requirements for a period of twenty-eight (28) days, the last seven (7) of which shall be consecutive, unless otherwise specified.

.3 Acceptance: For the purpose of this Specification section, Acceptance shall be defined as the formal turnover of a system to the City for his operation and maintenance. This shall occur after the successful end of Commissioning of each system through a formal agreement between the Contract Administrator, the City, and the Contractor. Success of the Commissioning Period is determined by the Contract Administrator.

4. COMMISSIONING TEAM

.1 The Work of Commissioning will be conducted by teams comprised of personnel from the Contractor, the City, and the Contract Administrator.

.2 The City's appointed staff shall represent process personnel and operating staff.

.3 The Contractor shall provide personnel representing the appropriate trades, including Instrumentation and Controls (I&C) personnel during the Commissioning. These personnel shall be skilled workmen, able to expedite any minor repairs, adjustments, etc., as are required to complete Commissioning with as few delays as possible.

5. COMMISSIONING PLAN

.1 The Commissioning Team shall develop a detailed methodology for the Commissioning of each system at least ninety (90) calendar days prior to planned start of Commissioning. The plan shall be drafted by the Contractor and Contract Administrator and include the following:

.1 Detailed Schedule of Events, including but not limited to the schedule for completion of testing of all component parts of the system in accordance with Section 01650 prior to Commissioning of a system.

.2 Method for introducing flow, disposing of partially treated effluent, and disposing of any sludge or other residual solids generated during the Commissioning process. The Contractor will take responsibility for the implementation of these measures.

.3 Sampling and analytical program for tests necessary to verify compliance with performance Specifications.

.4 Planned attendance schedule for Manufacturer's Representatives.

.5 Contingency plans in the event of a process malfunction.

.6 Drawings and sketches as required to illustrate the planned sequence of events.

.7 List and details for all temporary equipment (pumps, etc.) required to facilitate Commissioning.

.8 List of all personnel who the Contractor plans for Commissioning and hand-over with information indicating their qualifications for this Work.

.2 The Commissioning Plan shall be reviewed and agreed by the Commissioning Team prior to its implementation. The Contract Administrator shall be the final arbiter.

6. EQUIPMENT

.1 All process, mechanical, electrical, control and miscellaneous equipment related to a system shall be successfully installed and tested in accordance with Section 01650 and any specific requirements noted in other divisions. Form 103 (Contractor-Supplied Equipment) or Form 203 (City - Supplied Equipment) shall be executed for each item.

.2 As required in Section 01300 – Submittals, Operation and Maintenance Manuals will be submitted and reviewed by the Contract Administrator.

.3 Staff training sessions shall be completed.

.4 Temporary equipment will be installed and tested as necessary to ensure that it functions reliably and consistently through the commissioning period.

.5 Conduct sampling and analysis in accordance with the requirements of the latest version of "Standard Methods for the Examination of Water and Wastewater", American Water Works Association (AWWA)/Water Environmental Federation (WEF).

7. CONTROLS

.1 All controls which are the responsibility of this Contractor shall be installed and tested prior to commissioning.

.2 The Contract Administrator shall arrange for the simulation of the control sequences or shall allow for the operation of the system without the features included in the Work of others. Every effort shall be made to ensure that the Commissioning Period provides for the full and comprehensive operation of the equipment under all anticipated normal and adverse operating conditions.

8. PLANT UTILITY SERVICES

.1 The City shall provide power, chemicals, and other ancillary services as necessary to operate the plant through the Commissioning Period. Provision of these services shall be limited to reasonable levels.

9. MANPOWER

.1 Supply all staff required during Commissioning as necessary to assist the City's staff in the operation of the plant.

.2 Supply competent staff capable of maintaining, repairing, and adjusting the equipment and controls to achieve the intended design functions during the Commissioning Period.

.3 Ensure equipment Manufacturer's Representatives are available as necessary to certify adjustments in equipment, to guide in setting correct operating limits, and to generally provide input as required for the appropriate operation of the equipment.

10. OPERATING DESCRIPTIONS

.1 Operating descriptions have been prepared for the plant systems. To some degree, the intent of these have been included in the Drawings and Technical Specifications. Other information outlining the operating requirements is available from the Contract Administrator. The Contractor will review these descriptions and will make himself familiar with the requirements in order that he can undertake commissioning in an appropriate manner.

11. DESIGN PARAMETERS

.1 Design parameters for the systems to be commissioned shall be as defined in the Specifications and/or the operating descriptions; as modified by the Commissioning Team. The Commissioning Team will identify to the Contractor, which parameters shall be modified prior to Commissioning and shall be responsible for any subsequent changes during the Commissioning Period.

12. PREPARATION

.1 Each item of equipment included in the system to be commissioned shall be satisfactorily tested and Form 103 (Contractor-Supplied Equipment) or Form 203 (City-Supplied Equipment) completed.

.2 Piping, wiring, and other conduit systems shall be finished and tested.

.3 Electrical connections shall be completed and inspected to the satisfaction of the governing authorities.

.4 All other regulatory inspections shall be completed to the satisfaction of the governing authorities.

.5 Control systems shall be completed and the related control software debugged.

13. SEQUENCE

.1 Systems shall be commissioned in a logical manner. Upstream components shall be commissioned first to the degree possible.

.2 The following sequence of events shall be followed:

.1 Operation and Maintenance (O&M) Manuals shall be available as per the requirements of Section 01300 at least fourteen (14) days prior to the start of Commissioning.

.2 The Contract Administrator will make Operating Descriptions available prior to testing. Draft Operating Descriptions are included in this Contract.

.3 Initial operator training shall be undertaken two (2) weeks prior to Commissioning.

.4 Equipment performance tests shall be conducted successfully.

.5 Start and run system in manual mode.

.6 Turn separate items of equipment to automatic in a planned and logical manner. Ensure that the control system is operating the equipment in a manner which precludes damage of the equipment and which is consistent with the process operating requirements.

.7 Commence Commissioning Period of twenty-eight (28) days. The equipment shall operate continuously and successfully through the last seven (7) days of a Commissioning Period. Minor failures shall not void the Commissioning Period. A minor failure is defined as one which does not present a safety hazard, does not impact overall process functioning and can be temporarily overcome by the use of available standby equipment. The last seven (7) days of the Commissioning Period shall be re-started if a critical failure occurs. A critical failure shall be deemed as one, which prohibits the process from functioning successfully for an eight (8) hour period or one, which creates a safety hazard.

.8 Upon completing the Commissioning Period, the system shall be granted formal acceptance by the Contract Administrator.

14. COMMISSIONING

.1 Water will be introduced to the system in a manner, which precludes the damage of any equipment or structures.

.2 Twice during the Commissioning Period, plant component settings will be modified to ensure that the system is subjected to flows and loads as close to design conditions as possible. Where necessary to achieve this, flows to the area being commissioned will be augmented to exaggerate the naturally occurring flows and loads. Where it is necessary to modify settings outside the limits of this Contract area within the plant, coordinate the changes with plant staff.

.3 Assist in the operation of the plant to achieve the process objectives.

.4 All components and systems shall be operated in the automatic/manual and the remote/local modes as required to prove proper operation.

.5 Ensure all bypasses and backup provisions function satisfactorily.

.6 All minor and major alarm conditions will be induced to ensure that the process reacts as intended, the applicable alarms are enunciated.

.7 Samples of process flows, when necessary to prove performance, will be obtained and analyzed on a regular basis.

15. ACCEPTANCE

.1 The Commissioning of a system shall be considered acceptable when the process has operated in a stable manner, satisfying the design criteria for a period of twenty-eight (28) days, the last seven (7) of which shall be continuous and consecutive, unless otherwise specified.

.2 When a process system has been commissioned satisfactorily, the process system shall be formally accepted for operation and routine maintenance by the City's forces. (A form will be provided by the Contract Administrator.) On successful completion of Commissioning Form 104 – Certificate of Satisfactory Process Performance attached to this specification will be signed by the representative of the Manufacturer, Contractor, Contract Administrator, and the City. Form 104 shall be used for both Contractor-Supplied and City-Supplied equipment.

.3 An Acceptance Meeting must be held at the end of the twenty-eight (28) day test to confirm the status of each system.

.4 Notice of Acceptance for the entire project will be granted when all systems have been commissioned and accepted, and all requirements of the General Conditions have been completed.

CERTIFICATE OF SATISFACTORY PROCESS PERFORMANCE
FORM 104

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Performance Testing Criteria. The equipment is therefore classed as "conforming".

PROJECT: _____

SYSTEM DESCRIPTION: _____

_____

TAG NO (S): _____

REFERENCE SPECIFICATION (S): _____

_____ _____
(Authorized Signing Representative of the Manufacturer) Date

_____ _____
(Authorized Signing Representative of the Contractor) Date

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

_____ _____
(Authorized Signing Representative of the City of Winnipeg) Date

END OF SECTION

CONTRACT CLOSEOUT

1. FINAL CLEANING

.1 When the Work is Substantially Performed, remove surplus Products, tools, construction machinery, and equipment not required for the performance of the remaining Work.

.2 Remove waste Products and debris and leave the Work clean and suitable for occupancy by City of Winnipeg (City).

.3 When the Work is Totally Performed, remove surplus Products, tools, construction machinery, equipment, waste Products, and debris.

.4 Leave the Work areas broom clean before the final inspection process commences.

2. SITE RESTORATION

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

.2 The Contractor will be responsible for grounds restoration (seeding or sodding), as determined necessary by the Contract Administrator.

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

END OF SECTION

OPERATING AND MAINTENANCE DATA

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 In some instances, this requirement is reinforced by additional references within individual Technical Specification Sections, however, the inclusion or exclusion of additional references within the Contract shall not supersede or otherwise limit the generality of the foregoing and these requirements shall govern.

.4 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. When more than one (1) model or size of equipment type is furnished, show the information pertaining to each model, option or size.

2. SUBMITTALS

.1 The submission and acceptance of the “Equipment Operating and Maintenance Instruction” manual is a condition precedent to the certification of substantial performance.

.2 Submit operation manuals and maintenance information in accordance with Section 01300. Submittals may be checked for general compliance with the requirements of this Section.

.3 Submit complete operations manuals and maintenance information as soon as possible after review of project submittals but no later than 120 days before the Date of Substantial Performance.

.4 Submit O&M data in electronic format: Text sections compatible with Microsoft Word 2000; Drawings and Graphics in PDF format.

3. GENERAL REQUIREMENTS

.1 Provide materials of equal clarity and quality as the originals.

.2 Provide Drawings, diagrams, and Manufacturer's literature which are legible.

.3 All instructions in these O&M manuals to be in simple language.

.4 Mark Manufacturer’s standard documents to delete extraneous information not applicable to the equipment, assembly, subassembly or material supplied. Cross out or remove and eliminate any extraneous material for models, options, or sizes not furnished.

4. OPERATION AND MAINTENANCE MANUAL CONTENTS AND ORGANIZATION

.1 Arrange the O&M Manual to match the numbering system in the Specifications.

.2 Provide the Manufacturer's standard O&M manuals for the equipment or instrument supplied. If the Manufacturer's standard manuals do not contain all the required information, provide the missing information in supplementary Documents and Drawings.

.3 When more than one (1) piece of identical equipment or instruments are supplied, provide only one (1) set of operations manuals.

.4 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.

.5 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 included in the same electronic manual.

.6 Provide a cover page, as the first page of each manual, with the following information:

.1 Contract name and number.

.2 Equipment number or, if more than one piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.

.7 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.

.8 Include the specific information described below in the O&M manuals:

.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 Equipment Data

.1 Insert Specification Section and completed Equipment and Instrumentation Data sheets for equipment supplied. Attach all Addenda, Change Orders (CO), and change directives that refer to that specific item of equipment

OPERATING AND MAINTENANCE DATA

.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 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 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, semiannually, annually, or fill in hours of operation.

.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 and 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 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 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 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".

5. 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.

6. COMMISSIONING DATA

.1 Provide in hard cover 3-ring binders for 215 mm x 280 mm paper labelled "Commissioning Data" one (1) copy of:

.1 All completed equipment testing and commissioning forms, arranged in Specification Section order.

.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.

7. WARRANTIES

.1 Provide in hard cover 3-ring binders for 215 mm x 280 mm paper labelled "Warranties" one (1) copy of:

.1 A list in Specification Section order of all warrants and guarantees required by the contract documents and all 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.

.2 Include, in Specification Section order, a copy of all written warrants and guarantees, which are required by the contract documents. Include all additional standard warrants and guarantees received by the contractor.

END OF SECTION

TABLE OF CONTENTS

DIVISION 02

Reviewed and Approved

Date

DEMOLITION OF STRUCTURES

1. GENERAL

1.1 Work Included

.1 Demolition and disposal of all materials removed from the existing Effluent Gate Chamber (EGC) to the extent required to allow for the new construction.

.2 Demolition and disposal of all materials removed from the existing Work to the extent required to allow for the new construction.

1.2 References

.1 Canadian Standards Association (CSA) S350, Code of Practice for Safety in Demolition of Structures.

1.3 Existing Conditions

.1 Structures to be demolished are to be based on their condition at time of examination prior to tendering.

.2 Demolition of spray or trowel-applied asbestos can be hazardous to health. Should material resembling spray or trowel-applied asbestos be encountered in the course of demolition Work, stop Work and notify the Contract Administrator immediately. Do not proceed until written instructions have been received from the Contract Administrator.

.3 Existing data on the EGC is available for review at the Contract Administrator's office.

1.4 Protection

.1 Prevent movement, settlement, or damage of adjacent services, walks, paving, trees, landscaping, adjacent grades, and parts of existing structures to remain. Provide bracing, shoring, and underpinning as required. Make good any damage caused by demolition.

.2 Take precautions to support affected structures and, if safety of existing construction being demolished or services appears to be endangered, cease operations and notify Contract Administrator.

.3 Prevent debris from blocking surface drainage systems and mechanical and electrical systems which must remain in operation.

2. PRODUCTS

2.1 Materials

.1 Except where noted otherwise, maintain possession of all materials being demolished and immediately remove from Site.

3. EXECUTION

3.1 Preparation

.1 Disconnect and reroute electrical and telephone service lines as required in accordance with authorities having jurisdiction. Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of demolition.

.2 Disconnect and cap designated buried services in accordance with authorities having jurisdiction.

.3 Do not disrupt active or energized utilities traversing premises.

.4 Employ rodent and vermin exterminators to comply with health and environmental regulations.

3.2 Safety Code

.1 Unless otherwise specified, carry out demolition Work in accordance with Section 01060 - Regulatory Requirements.

3.3 Demolition

.1 Demolish parts of existing structure to permit construction of new Work as indicated.

.2 Cut openings in existing structures to clean neat lines and surfaces.

.3 Obtain Contract Administrator’s acceptance prior to use of vibratory equipment on existing structures.

.4 Remove existing equipment, services, and obstacles where required for refinishing or making good of existing surfaces, and replace as Work progresses.

.5 At end of each day’s Work, leave Work in safe condition so that no part is in danger of toppling or falling. Protect interiors of parts not to be demolished from exterior elements at all times.

.6 Demolish to minimize dusting. Keep materials wetted as directed by Contract Administrator.

.7 Remove and properly dispose of demolished materials except where noted otherwise and in accordance with authorities having jurisdiction.

END OF SECTION

EXCAVATION AND BACKFILLING FOR STRUCTURES

1. GENERAL

1.1 Description

.1 Work includes, but is not necessarily limited to the following items:

.1 Excavating for Work required under this Contract generally including, but not limited to, the effluent gate chamber connection, pump influent wet well channel, bypass channel, pumping station, ultraviolet (UV) influent channel, UV distribution chamber, UV channels, effluent channel, outfall junction chamber, UV building, and mechanical and electrical equipment pads and encasements.

.2 Supply, placing, and compaction of backfill and fill materials to attain indicated grades and profiles.

.3 Disposal of surplus excavated material.

.4 Dewatering, shoring, and bracing of excavations.

1.2 Job Conditions

.1 Examination

.1 Visit the Site and note all characteristics and irregularities affecting the Work of this Section.

.2 To proceed with the Work will mean acceptance of the conditions, and failure to comply with the above will in no way form the basis for any claim.

.3 Review the Geotechnical Report prior to submitting Bid for the Work.

.2 Protection

.1 Use all means necessary to protect all materials of this Section before, during, and after installation, and to protect all objects designated to remain.

.2 In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Contract Administrator and at no additional cost.

.3 Protect benchmarks and structures against damage from equipment and vehicular traffic.

1.3 Reference Standards

.1 Conform to requirements of the National Building Code (NBC) and the Canadian Construction Safety Code.

.2 Comply with excavation and trenching regulations of Provincial authorities.

1.4 Samples

.1 If requested by Contract Administrator submit 25 kg sample of each type of fill material specified for analysis by testing laboratory; for coarse, gravelly soil or coarse, crushed stone, submit 75 kg sample of each.

.2 Ship samples prepaid or deliver in tightly closed containers to testing laboratory designated by Contract Administrator.

.3 Costs for analysis will be paid by the City.

1.5 Compaction Testing

.1 Testing of compacted fill materials will be performed by an independent inspection and testing firm appointed and paid by the City. Testing will be performed so as to least encumber the performance of Work.

.2 The City will pay for the first series of tests only, on the area being evaluated. Pay costs for additional testing, if required, due to improper performance of Work.

.3 Tests are to be performed in accordance with American Society for Testing and Materials (ASTM) D698 for Standard Proctor Density.

.4 Notify the Contract Administrator when Work of this Section or portions of Work are completed to own satisfaction. Do not proceed with additional portions of Work until test results have been verified and accepted.

.5 During Work tests, if tests indicate that compacted materials do not meet specified required materials, remove defective Work, replace and re-test at own expense as directed by the Contract Administrator.

.6 Ensure compacted fills are tested and accepted before proceeding with placement of surface materials.

2. PRODUCTS

2.1 General

.1 All materials to be subject to Contract Administrator's acceptance.

.2 Granular materials to be composed of sound, hard, uncoated particles, free from injurious quantities of clay, flaky particles, soft shale, friable materials, roots, vegetable matter, and frozen lumps.

.3 Grading of granular materials to show no marked fluctuations between opposite ends of extreme limits.

.1 Type 1: select pit run gravel or crushed natural stone graded within the following limits:

Canadian Metric Sieve Size	Percent Passing
75,000	100
25,000	80 - 100
5,000	40 - 70
2,200	25 - 50
425	10 - 35
80	5 - 30

.2 Type 2: crushed gravel graded within following limits:

Canadian Metric Sieve Size	Percent Passing	
	Crushed Granular	Crushed Limestone
25,000	100	-
20,000	80 - 100	100
5,000	40 - 70	40 - 70
2,500	25 - 55	25 - 60
315	13 - 30	8 - 25
80	5 - 15	6 - 17

.3 At least 60% of material retained on 5 mm sieve to have at least one (1) freshly fractured face.

.4 Type 3: natural river or beach sand, free from silt, clay, loam, friable, or soluble material and vegetable matter, graded within the following limits:

Canadian Metric Sieve Size	Percent Passing
10,000	100
5,000	90 - 100
630	25 - 60

80 0 - 3

.4 Type 4: common backfill free from organic material and rocks larger than 150 mm in size and building debris. Fill under landscaped areas to be free from alkali, salt, petroleum products and other materials detrimental to plant growth. Use subsoil excavated from Site only if accepted by Contract Administrator and if conforming to requirements for Type 4.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities crossing the Work Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, maintain roadways in a clean and safe condition and, at the completion of the Contract, clean and restore all roads used to perform the Contract.

3.2 Finish Elevations and Lines

.1 For setting and establishing finish elevations and lines, secure the services of a registered surveyor or experienced instrumentman acceptable to the Contract Administrator.

.2 Carefully preserve all data and all monuments set by him. If displaced or lost, immediately replace to the acceptance of the Contract Administrator, at no additional cost to the City.

3.3 Excavation

.1 Two (2) weeks prior to commencement of the Work, submit an excavation plan sealed by qualified Professional Engineer registered in the Province of Manitoba to the Contract Administrator for review.

.2 Submit excavation plan sealed by qualified Professional Engineer registered in the Province of Manitoba to the Contract Administrator for review two (2) weeks prior to commencement of the Work.

.3 Perform excavation in strick compliance to Work Place Safety and Health and authorities have jurisdiction.

.4 Excavate to noted limits and as required for walls and foundations. Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately as per Item 3.6.

.5 When complete, request Contract Administrator to review excavations.

.6 Excavate materials indicated in the Geotechnical Report for the purpose of removing loading on existing structures.

.7 Local pockets of material which, in the opinion of the Contract Administrator are unsuitable, shall be removed to such depths as required by the Contract Administrator.

.8 The completed excavation shall provide clean, level, solid, and water-free surfaces at the required elevations, ready to receive construction.

.9 Excavations are not to encroach on normal 45° bearing support under any foundation or structure and as indicated in the Geotechnical Report.

.10 Backfill and compact all over-excavated areas under structure bearing surfaces and footings with Type 1 fill and compact to 95% Standard Proctor Density and at no additional cost to the City.

.11 Make good all damage occurring as a result of inadequate, unauthorized, or defective methods of protection.

.12 Areas used for temporary stockpiling shall be restored to existing condition or better.

3.4 Shoring, Bracing, Sheet Piling

.1 Provide all shoring, bracing, and sheet piling required to prevent damage to existing structures, excavations, and injury to personnel as indicated on the Drawings.

.2 Two (2) weeks prior to commencement of the Work, submit a shoring design sealed by qualified Professional Engineer registered in the Province of Manitoba to the Contract Administrator for review

.3 Comply with all applicable rules and regulations of governmental authorities.

.4 Erect shoring, bracing, and sheet piling independent of utilities and structures.

.5 Prefabricated cages or shields may be used to supplement or replace conventional shoring, provided they comply with all applicable safety regulations and permit placing and tamping of bedding material under and around new construction.

.6 Maintain shoring, bracing, and sheet piling during backfilling and remove in stages as backfilling progresses.

.7 Remove all shoring, bracing, and sheet piling unless otherwise permitted by Contract Administrator.

.8 If shoring, bracing, and sheet piling are allowed to remain, cut off to an elevation at least 1,000 mm below finish grade and structures.

.9 Assume full responsibility for any failure, collapse, or movement of existing structures, shoring, bracing, sheet piling, earth banks, trenches, and other excavations.

3.5 Dewatering

.1 Excavation, pits, and the entire sub-grade in the vicinity of the Work shall be kept free of water. Positive surface drainage shall be maintained away from the excavation at all times. Provide and operate pumps or other suitable equipment, and provide and maintain a temporary drainage system within the excavation. Discharge from pumps or other dewatering equipment shall be located and controlled such that loss, damage, nuisance, or injury to the Work does not result. Additional excavation made necessary by water in the excavation shall be at no additional cost to the City.

3.6 Backfilling, Fill, and Compaction

.1 Preparation

.1 Ensure areas to be backfilled are free from debris, snow, ice, and water and that ground surfaces are not in a frozen condition.

.2 Perform all necessary compaction of existing sub-grade surfaces under structures and slabs on grade if densities are not equal to that required for fill materials.

.3 Cut out soft areas of existing sub-grade, backfill with Type 1 fill, and compact to density specified for fill.

.2 Backfilling and Filling

.1 Backfill and fill to grades, contours, levels, and elevations indicated on Drawings.

.2 Where temporary unbalanced pressures are liable to develop on walls, erect necessary shoring to counteract imbalance.

.3 Backfill simultaneously on both sides of walls to equalize soil pressures and to prevent unbalanced loading conditions.

.4 Exercise care when backfilling on top of existing and new structures. Refer to the Geotechnical Report for requirements.

.5 Do not backfill water-containing structures until after the watertightness tests have been completed and the structures accepted by the Contract Administrator.

.6 Do not backfill against foundation walls until the roof and floor slabs have been completed and without the prior permission of the Contract Administrator. The wall concrete must have attained the 28-day minimum compressive strength before backfilling. The roof concrete must have attained 75% of the 28-day minimum compressive strength before backfilling.

.7 After sub-grade has been accepted by the Contract Administrator, spread accepted fill material in layers, not exceeding specified uncompacted thickness, and then compact to required density prior to the addition of the next layer.

.8 Maintain optimum moisture content of materials to permit compaction to specified densities.

.3 Compaction and Fill Types

.1 Compact each soil layer to at least the specified minimum degree; repeat compaction process until plan grade is attained. Compaction densities indicated herein are based on ASTM D698 for Standard Proctor Density.

.2 Type 1 fill sub-base shall be placed in uniform lifts not greater than 150 mm in thickness and shall be compacted to a density of at least 100% Standard Proctor to correct over excavation.

.3 Type 2 fill under concrete slabs on grade shall be placed in uniform lifts not greater than 150 mm in thickness and shall be compacted to a density of at least 100% Standard Proctor.

.4 Type 4 fill to be placed in lifts not greater than 300 mm in thickness around the structure and shall be compacted to a density of at least 95% Standard Proctor.

3.7 Disposal

.1 Surplus material not required for backfill and fill purposes shall be disposed of off-site within the City limits to a location designated by the City at no extra cost to the City.

3.8 Clean-Up

.1 As excavation proceeds, keep roads, streets, and sidewalks clean of dirt and excavated material.

.2 Clean-up and wash down to remove all dirt and excavated materials caused by Work of this Section.

.3 Clean at the end of each working day as directed by the Contract Administrator.

END OF SECTION

PILE FOUNDATIONS, GENERAL

1. GENERAL

1.1 Description

.1 This Section provides the requirements associated with the installation of precast concrete piles as specified in Section 02468.

1.2 Delivery, Storage and Handling

.1 Protect piles from damage due to excessive bending stresses, impact, abrasion, or other causes during delivery, storage, and handling.

.2 Replace damaged piles to satisfaction of Contract Administrator.

1.3 Existing Conditions

.1 Review the Geotechnical Report prior to submitting Tender for the Work.

.2 Notify Contract Administrator in writing if subsurface conditions at Site differ from those indicated and await further instructions from Contract Administrator.

1.4 Scheduling

.1 Submit schedule of planned sequence of driving to Contract Administrator for review, not less than two (2) weeks prior to commencement of pile driving.

2. PRODUCTS

2.1 Materials

.1 Material requirements for piles are specified in Section 02468.

.2 Supply or fabricate full length piles as indicated and provide equipment to handle full length piles without cutting and splicing.

.3 Do not splice piles without written permission of Contract Administrator. When permitted, provide details for Contract Administrator review. Design details of splice to bear dated signature stamp of Professional Engineer registered in the Province of Manitoba.

3. EXECUTION

3.1 Equipment

.1 Prior to commencement of pile installation, submit to Contract Administrator for review, details of equipment for installation of piles.

.1 Impact hammers: give Manufacturer's name, type, rated energy per blow at normal working rate, mass of striking parts of hammer, mass of driving cap and type and elastic properties of hammer and pile cushions.

.2 Hammer:

.1 Hammers to be selected on basis of driveability analysis using wave equation theory, performed to show that piles can be driven to levels indicated.

.2 The driveability analysis shall include, but not be limited to, the following: hammer, cushion, and capblock details; static soil parameters; quake and damping factors, total soil resistance, blow count, pile stresses, and energy throughput at representative penetrations.

.3 Driveability analysis shall be submitted to the Contract Administrator for review of the hammer or hammers.

.4 When required criteria cannot be achieved with the proposed hammer, use larger hammer and take other measures as required.

.5 Drop hammers are not permitted.

.3 Leads:

.1 Construct pile driver leads to provide free movement of hammer. Hold leads in position at top and bottom, with guys, stiff braces, or other means to ensure support to pile while being driven.

.2 Length: provide length of leads so that use of a follower is unnecessary.

.3 Swing leads: firmly guy top and bottom to hold pile in position during driving operation.

.4 Followers: when permitted, provide followers of such size, shape, length, and mass to permit driving pile in desired location to required depth and resistance. Provide followers with socket or hood carefully fitted to top of pile to minimize loss of energy and prevent damage to pile.

3.2 Preparation

.1 Ensure that ground conditions at pile locations are adequate to support pile driving operation and load testing operation. Make provision for access and support of piling equipment during performance of Work.

.2 Pre-bore holes for piles within 5 m of the existing structures.

.3 Pre-bore with an oversized auger bit to the depths as indicated in the Geotechnical Report.

.4 Record the condition of the existing structures (with photographs or other means) prior to commencing pile driving operations.

3.3 Field Measurement

.1 Maintain accurate records of driving for each pile, including:

.1 Type and make of hammer, stroke or related energy.

.2 Other driving equipment including water jet, driving cap, cushion.

.3 Pile size and length, location of pile in pile group, location or designation of pile group.

.4 Sequence of driving piles in group.

.5 Number of blows per 25 mm (1 in.) for last 150 mm (6 in.).

.6 Final tip and cut-off elevations.

.7 Re-driving records.

.8 Other pertinent information such as interruption of continuous driving and pile damage.

.9 Record elevation taken on adjacent piles during, before, and after driving of each pile.

.10 All measurements, observations and calculations associated with pile driving analyzer and wave equation analysis.

.2 Provide Contract Administrator with three (3) copies of records.

3.4 Driving

.1 Drive precast piles only when concrete has attained strength of 35 MPa.

.2 Use driving caps and cushions to protect piles. Reinforce pile heads as required by Contract Administrator. Piles with damaged heads as determined by Contract Administrator will be rejected.

.3 Hold piles securely and accurately in position while driving.

.4 Deliver hammer blows along axis of pile.

.5 Drive piles to practical refusal, as outlined in the Geotechnical Report.

.6 When driving precast concrete piles, adjust hammer, as required, to deliver reduced impact so that reflected tensile stress in pile does not exceed allowable.

.7 Do not drive piles within 10 m of masonry or concrete which has been in place less than seven (7) days.

.8 Re-strike already driven piles lifted during driving of adjacent piles to confirm and assure set.

.9 Remove loose and displaced material from around piles after completion of driving, and leave clean, solid surfaces to receive foundation concrete.

.10 Cut off piles neatly and squarely at elevations as indicated. Provide sufficient length above cut-off elevation so that part damaged during driving is cut off. Do not cut tendons or other reinforcement which will be used to tie supported structure above to pile.

.11 Remove cut-off lengths from Site on completion of Work.

3.5 Design Load Capacity

.1 Allowable design load capacity of piles at specified loads is:

.1 300 mm diameter hex - 445 kN

.2 350 mm diameter hex - 625 kN

.3 400 mm diameter hex - 800 kN.

.2 Installation of each pile will be subject to review of Contract Administrator. Contract Administrator will be sole judge of acceptability of each pile with respect to final driving resistance, depth of penetration, or other criteria used to determine load

capacity. Contract Administrator to review final driving of all piles prior to removal of pile driving rig from Site.

3.6 Driving Tolerances

.1 Pile heads shall be within ± 50 mm of locations as indicated.

.2 Piles shall not to be more than 2% of length out of vertical alignment.

3.7 Obstructions

.1 Where obstruction is encountered that causes sudden unexpected change in penetration resistance or deviation from specified tolerances, proceed as directed by Contract Administrator.

3.8 Repair / Restoration

.1 The Contract Administrator may require one (1) or more of the following remedial measures:

.1 Pull out rejected piles and replace with new piles.

.2 Remove rejected pile and replace with a new, and if necessary, a longer pile.

.3 Remove rejected pile and fill hole as directed by Contract Administrator.

.4 Leave rejected pile in place and cut off as directed by Contract Administrator.

.5 Leave rejected pile in place, place adjacent pile(s), and modify pile cap as directed by Contract Administrator.

.2 No extra compensation will be made for removing and replacing or other Work made necessary through rejection of defective piles.

3.9 Protection

.1 Protect adjacent structures, services, and Work of other sections from hazards due to pile driving operations.

.2 Arrange sequencing of pile driving operations and methods such that no damage occurs to adjacent existing structures. If damaged, remedy damaged items to restore to original or better condition at own expense.

END OF SECTION

PRECAST CONCRETE PILES

1. GENERAL

1.1 Work Included

.1 Fabrication, delivery, and installation of precast concrete piles.

1.2 References

.1 Canadian Standards Association (CSA)

.1 CSA-A23.1-00/A23.2-00, Concrete Materials and Methods of Concrete Construction/ Methods of Test for Concrete.

.2 CSA A23.4/A251, Precast Concrete – Materials and Construction/Qualification Code for Architectural and Structural Precast Concrete Products.

.3 CAN/CSA-A3000, Cementitious Materials Compendium (consists of A5, A8, A23.5, A362, A363, A456.1, A456.2, and A456.3).

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Each Drawing submitted shall bear the signature and stamp of qualified Professional Engineer registered in the Province of Manitoba.

.3 Indicate the following items:

.1 Lifting point details and locations.

.2 Storage support point locations.

.3 Connector details complete with calculations.

.4 Rock points.

.5 Concrete strength.

.6 Steel grades.

.7 Reinforcing details.

.8 Type and grade of steel.

1.4 Certificates

.1 Piles delivered to Site to be certified by Manufacturer that each batch of piles to have strength of 35 MPa at 28 days.

1.5 Review and Monitoring

.1 Notify Contract Administrator at least four (4) days prior to pile driving operations.

.2 Pile driving review and monitoring is to be performed by a geotechnical inspection and testing firm appointed and paid by the City. Field measurement and maintenance of accurate records of driving for each pile is the responsibility of the contractor as per Specification Section 02451.

.3 Provide free access to all portions of Work and cooperate with appointed firm.

2. PRODUCTS

2.1 Materials

.1 Concrete mixes and materials: to CSA-A23.1-00 and CSA-A23.4.

.2 Reinforcing steel: to CAN/CSA-G30.18.

.3 Spiral reinforcement: to CSA G30.3.

.4 Pile connections: capable of providing positive means to hold pieces together, maintaining alignment for full depth and transmitting full design load.

2.2 Concrete Mixes

.1 Proportion normal density concrete in accordance with CSA-A23.1-00, Alternative 1, to give following properties:

.1 Use Type 50 cement.

.2 Minimum compressive strength at twenty-eight (28) days: 35 MPa.

.3 Minimum cement content: 365 kg/m^3 of concrete.

.4 Maximum water/cement ratio: 0.45.

.5 Nominal size of coarse aggregate: 16 mm maximum.

.6 Air content: 5 to 8%, to American Society for Testing and Materials (ASTM) Standard C260.

.7 Chemical admixtures: in accordance with ASTM Standard C494.

.8 Pozzolanic mineral admixtures: in accordance with CSA A23.5.

3. EXECUTION

3.1 Fabrication

.1 Fabricate precast concrete piles to lengths determined through the soils information and required cut-off elevations.

.2 Fabricate piles to following finish tolerances:

.1 Length: plus or minus 3 mm/m of length.

.2 Cross section:

.1 Solid sections: minus 5 to plus 10 mm.

.2 Deviation from straight line: not more than 3 mm/m of length; 10 mm in full length.

.3 Deviation of internal core or void from true position: 10 mm.

.4 Pile head: 10 mm/m from true right angle plane; surface irregularities 3 mm.

.5 Location of reinforcing steel main reinforcing cover: minus 3 to plus 5 mm; spiral: 10 mm.

.3 Prestress piles under the direction of an experienced and competent supervisor. All personnel operating the stressing equipment shall have been trained in its use.

.4 De-tension in a manner to keep eccentricity to a minimum. Release prestress prior to cutting prestress strands.

.5 Quality and dimensions of piles will be determined by Contract Administrator. Remove rejected piles from Site.

3.2 Handling

.1 Ensure handling and installation stresses are within safe limits.

3.3 Installation

.1 Install piles in accordance with Section 02451 - Pile Foundations, General.

.2 Splice piles as indicated on reviewed Shop Drawings.

.3 Cut off piles at required elevation. Prevent spalling of pile concrete below cut-off elevation.

END OF SECTION

WATERMAINS

1. GENERAL

1.1 Work Included

.1 Construction of new watermains, hydrants and valves, including connection to the existing watermain.

.2 Construction of new water service off the new watermain to service the new Secondary Effluent Disinfection Facility.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications- latest edition are applicable to the Work:

.1 CW 2030-R6 Excavation, Bedding and Backfill

.2 CW 2110-R7 Watermains

.3 CW 2125 Flushing, Hydrostatic Testing and Disinfection of Watermains and Water Services

.4 CW 2160 Concrete Underground Structures and Works

.5 Division 3 Standard Details – Underground Works

SD-001 Standard Pipe Bedding

SD-002 Standard Trench and Excavation Backfill

SD-003 Jetting Nozzle Insertion Locations

SD-004 Concrete Thrust Blocks for Horizontal Watermain Fittings

SD-005 Concrete Thrust Blocks for Vertical Watermain Fittings

SD-006 Standard Fire Hydrant Assembly

SD-007 Short Fire Hydrant Assembly

SD-008 Location Map for Watermain Valve Closing Direction

SD-012 Water Service 20 Millimeter to 50 Millimeter

SD-016 Standard Watermain Valve Installation

SD-018 Watermain and Water Service Insulation

SD-019 Backflow Protection Arrangement for Water Supply from Hydrant

.6 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed as Approved Products for Underground Use in the City of Winnipeg.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities serving the Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, and at the completion of the Contract, all roads used to haul materials shall be cleaned of materials dropped on them.

.3 Operation of Valves

.1 Valves and hydrants on existing watermains and feedermains and on new watermains connected to the existing system are only to be operated by personnel from the Water Services Division of the Water and Waste Department.

.2 Schedule valve operations with Water Service Division a minimum twenty-four (24) hours prior to the required shut down or turn on.

.3 Submit schedule of all valve operations to the Contract Administrator and maintain a record of all valve operations performed by the Water Services Division.

3.2 Excavation, Bedding and Backfill

.1 Do excavation, bedding and backfill to CW 2030.

.2 Backfill requirements are as follows:

.1 Beneath, or within 1 m of all existing and proposed pavements and walks: Class 2 Backfill.

.2 Within the extents of excavations for structures, backfill in accordance with Section 2220 – Excavating and Backfilling for Structures.

.3 Within boulevard areas, except as noted above: Class 4 Backfill.

.3 Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately off-site.

.4 All excavated or disturbed areas are to be restored to a condition better than or equal to original. Restoration of boulevard areas will be with topsoil and sod; seeding will not be acceptable.

3.3 Installation

.1 Installation to CW 2110.

.2 Install pipes by trenchless methods under all existing or proposed pavements and walks.

3.4 Connection to the Existing System

.1 Locate and confirm size and material of the existing watermain prior to making connection.

.2 Submit schedule of connection to Contract Administrator 48 hours prior to Work.

.3 Limit interruption of service during connection to a maximum of four (4) hours.

3.5 Testing

.1 Perform hydrostatic leakage testing and disinfect pipe in accordance with CW 2125.

.2 New installations may be put into service upon meeting all requirements of Clause 3.5 of CW 2125.

END OF SECTION

SANITARY SEWERS

1. GENERAL

1.1 Work Included

.1 Construction of new sanitary sewer service to service the new Secondary Effluent Disinfection Facility, including new sewers, manholes, and connection to the existing sanitary sewer.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications- latest edition are applicable to the Work:

.1 CW 2030-R6 Excavation, Bedding and Backfill

.2 CW 2130-R8 Gravity Sewers

.3 CW 2160 Concrete Underground Structures and Works

.4 Division 3 Standard Details – Underground Works

SD-001 Standard Pipe Bedding

SD-002 Standard Trench and Excavation Backfill

SD-003 Jetting Nozzle Insertion Locations

SD-010 Standard Precast Concrete Manhole (for up to 525 Diameter Pipe)

SD-014 Sewer Service with Alternate “A” Riser

SD-015 Sewer Service with Alternate “B” Riser

SD-022A Sewer Repair Up to 3.0 Meters Long

.5 Division 3 Approved Products for Underground Works

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed as Approved Products for Underground Use in the City of Winnipeg.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities serving the Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 During construction, and at the completion of the Contract, all roads used to haul materials shall be cleaned of materials dropped on them.

3.2 Excavation, Bedding and Backfill

.1 Do excavation, bedding and backfill to CW 2030.

.2 Backfill requirements are as follows:

.1 Beneath, or within 1 m of all existing and proposed pavements and walks: Class 2 Backfill.

.2 Within 2 m of all manholes: Class 2 Backfill

.3 Within the extents of excavations for structures, backfill in accordance with Section 2220 – Excavating and Backfilling for Structures.

.4 Within boulevard areas, except as noted above: Class 4 Backfill.

.3 Stockpile material to be used for backfilling on-site as directed by the Contract Administrator. Excess material is to be disposed of immediately off-site.

.4 All excavated or disturbed areas are to be restored to a condition better than or equal to original. Restoration of boulevard areas will be with topsoil and sod; seeding will not be acceptable.

3.3 Installation

.1 Installation to CW 2130.

.2 Install pipes by trenchless methods under all existing or proposed pavements and walks.

3.4 Connection to the Existing System

.1 Locate and confirm size and material of the existing sewer prior to making connection.

.2 Submit schedule of connection to Contract Administrator 48 hours prior to Work.

END OF SECTION

THERMAL INSULATION FOR UNDERGROUND PIPING

1. GENERAL

1.1 Related Work

.1 Sanitary Sewers: Section 02530

1.2 Material Specifications

.1 At least two (2) weeks prior to commencing Work, submit Manufacturer's test data and certification that insulation materials meet the requirements of this Section. Include Manufacturer's Drawings, information and Shop Drawings where pertinent.

2. PRODUCTS

2.1 Application

.1 Insulation system for sewer mains.

2.2 Materials

.1 Thermal insulation: to be factory applied, rigid, closed-cell polyurethane insulation to a thickness of 50 mm, Shaw Pipe Protection "Insul-8" systems or Urecon Ltd. "U.I.P." system meeting the following requirements:

.1	Core density, ASTM D-162235	48 kg/m^3
.2	Compressive strength, ASTM D1621	275 kPa
.3	Thermal conductivity, ASTMC518	0.020 W/cm^0C to 0.022 SW/cm^0C
.4	Service temperature	-45^0C to 85^0C
.5	Closed Cell content, ASTM D2856;	90% minimum
.6	Water absorption, ASTM D2127;	4.25% by volume
.7	Dimensional stability, ASTM D2126, procedure B & E	3

.2 Protective jacketing to be either of the following:

.1 A 1.14 mm thickness of continuously extruded high density polyethylene over a rubber mastic under-adhesive as manufactured by Shaw Pipe Protection, "Insul 8" system.

- OR -

.2 A 1.27 mm thickness in two (2) layers spirally wrapped high density polyethylene tape, hot applied, counter-wound, overlapped 15% of tape width on each seam, Urecon Ltd. "U.I.P." system.

.3 Heat shrink sleeves: Adhesive coated cross-linked polyethylene sleeve to provide a moisture-proof seal at joints in 150 mm widths.

.4 Mastic: Flintguard No. 110-14 asphalt mastic vapor barrier.

3. EXECUTION

.1 Clean all surfaces adequately prior to applying adhesives, polyurethane, mastic, shrink sleeves or tape. Remove and replace any materials where proper bond is not attained.

.2 Transport, store and handle insulated components with care to prevent damage to insulation and/or protective jacket.

.3 Repair damaged insulation with field-applied urethane. Repair damaged protective jacket with heat shrink sleeves or heat shrink tape.

.4 Do jointing as required. Cut back insulation on pipe to provide snug fit.

.5 Coat all exposed surfaces of pipe insulation with mastic.

END OF SECTION

PORTLAND CEMENT CONCRETE PAVEMENT FOR BUILDING SITES

1. GENERAL

1.1 Work Included

.1 Construction of new roadways and walks, including excavation, supply and installation of base and sub-base materials, Portland cement concrete paving and miscellaneous items.

.2 Removal of existing pavements.

1.2 References

.1 The following Specifications of the City of Winnipeg Standard Construction Specifications- latest edition are applicable to the Work:

.1 CW3010-R4 Clearing and Grubbing

.2 CW3110-R6 Sub-Grade, Sub-Base and Base Course Construction

.3 CW3130 Supply and Installation of Geotextile Fabrics

.4 CW3310-R7 Portland Cement Concrete Pavement Works

.5 CW3325-R2 Portland Cement Concrete Sidewalk

.6 CW3410-R5 Asphaltic Concrete Pavement Works

.7 CW3450-R3 Planing of Pavement

.8 CW3710-R4 Products Approved for Use in Surface Works

.9 Division 4 - Standard Details Surface Works

SD-203A Barrier Curb (Separate)

SD-209 Keyway for Portland Cement Concrete Pavement

SD-210A Longitudinal Joint for Concrete Pavement

SD-210B Tie Bar Installation for Lane-At-A-Time Paving Where Bending of Tie Bars is Required

SD-211A Construction Joint and Contraction Joint for Reinforced Concrete Pavement

SD-212 Sawn Joint, Keyed Joint and Butt Joint for Reinforced, Plain Concrete and Plain-Dowelled Pavement

SD-216 Placement of Steel in Reinforced Concrete Pavements, 5000 mm Joint Spacing

SD-217 Layout for Type "A" and "B" Barmat Reinforcement, 5000 mm Joint Spacing

SD-218A Typical Joint Details for Portland Cement Concrete Pavements

SD-218B Location of Longitudinal Joints in Concrete Pavements

SD-228A Concrete Sidewalk

.2 Measurement and payment clauses in the above Specifications are not applicable to the Contract.

.3 Division 2 General Requirements of the City of Winnipeg Standard Construction Specification are not applicable to the Work.

2. PRODUCTS

2.1 Materials

.1 Use only those Products listed in the Surface Works Approved Products in the City of Winnipeg Standard Construction Specifications.

.2 Use only approved concrete mixes from approved concrete suppliers.

3. EXECUTION

3.1 General

.1 Familiarization

.1 Prior to all Work of this Section, become thoroughly familiar with the Site, the Site conditions, and all portions of the Work falling within this Section.

.2 Review and understand the Geotechnical Report.

.2 Protection

.1 Before starting Work, locate all utilities serving the Site. Notify all agencies or companies having jurisdiction over the specific utilities and protect, relocate, remove, or discontinue service according to their requirements. Any damages shall be repaired at the Contractor's expense.

.2 Protect and restore pavements, boulevards, grassed areas, etc., that may be opened or damaged in the performance of the Work.

.3 The Contractor shall take the following precautionary steps to prevent damage from construction activities to existing boulevard trees within the limits of the construction area:

.1 The Contractor shall not stockpile materials and soil or park vehicles and equipment on boulevards within 2 m of trees.

.2 Trees identified to be at risk by the Contract Administrator are to be strapped with 25 x 100 x 2400mm wood planks, or suitably protected as approved by the Contract Administrator.

.3 Excavation shall be performed in a manner that minimizes damage to the existing root systems. Where possible, excavation shall be carried out such that the edge of the excavation shall be a minimum of 1.5 times the diameter (measured in inches), with the outcome read in feet, from the closest edge of the trunk. Where roots must be cut to facilitate excavation, they shall be pruned neatly at the face of excavation.

.4 Operation of equipment within the dripline of the trees shall be kept to the minimum required to perform the Work required. Equipment shall not be parked, repaired, refueled; construction materials shall not be stored, and earth materials shall not be stockpiled within the driplines of trees. The dripline of a tree shall be considered to be the ground surface directly beneath the tips of its outermost branches. The Contractor shall ensure that the operations do not cause flooding or sediment deposition on areas where trees are located.

.4 During construction, and at the completion of the Contract, all roads used to haul materials shall be cleaned of materials dropped on them.

3.2 Excavation

.1 Strip topsoil in accordance with CW-3110 in all areas on-site where proposed concrete pavement and sidewalks are required. Haul all stripped material off-site.

.2 Grub out all roots within paving limits in accordance with CW-3010. Dispose of off-site.

.3 Saw cut and remove existing pavement to the limits shown on the Drawings in accordance with CW-3110. Haul material and dispose of off-site.

.4 Excavate to the lines and grades shown on the Drawings and Surface Works Standard Details in accordance with CW-3110. Dispose of all excavated material off-site.

3.3 Subgrade Preparation

.1 Prepare subgrade in accordance with CW-3110. Upon approval of the excavation bottom by the Contract Administrator, compact subgrade to 95% Standard Proctor Density.

.2 Place and compact additional suitable Site material as required to bring subgrade up to bottom of sub-base elevation for roads and base course elevation for walks.

.3 Prior to installation of Geotextile fabric, proof roll subgrade. Notify Contract Administrator of Defective areas of subgrade. Excavate and remove defective subgrade areas as directed by the Contract Administrator. Backfill excavated areas with suitable Site material as directed by the Contract Administrator.

.4 Install separation/reinforcement geotexile fabric in accordance with CW-3130 as indicted on the Drawings and Surface Works Standard Details.

3.4 Sub-base and Base Course Construction

.1 Construct sub-base and base course to the lines and grades shown on the Drawings in accordance with CW-3110 for roadways and approaches.

.2 Construct base course for sidewalks as shown on Surface Works Standard Details in accordance with CW-3325.

3.5 Paving

.1 Construct roadways and approaches as shown on the Drawings and Surface Works Standard Details in accordance with CW-3310.

.2 Construct sidewalks as shown on the Drawings and Surface Works Standard Details in accordance with CW-3325.

.3 In fill sections, construct boulevards to a minimum elevation equal to bottom of slab adjacent to sub-base and base course prior to paving.

.4 Plane existing asphalt at tie-ins to new pavement as shown on the Drawings in accordance with CW-3450. Construct new Type 1A asphalt pavement overlay through planed sections to match existing asphalt to new Portland cement pavement in accordance with CW-3410.

3.6 Precast Parking Curbs

.1 Precast concrete parking curbs will be “Barkman Spikma Precast Bumper Curb” or approved equal, complete with hold-down bars.

.2 Hold-down bars shall consist of 15 m deformed, grade 300 reinforcing steel. The hold-down bars shall be 600 mm in length with two (2) bars installed per curb section.

END OF SECTION

TABLE OF CONTENTS

DIVISION 03

Reviewed and Approved

Date

CONCRETE FORMWORK

1. GENERAL

1.1 Work Included

.1 Forms for all concrete and supporting falsework including design.

.2 Formliner all for interior wall surfaces of water retaining structures.

.3 Wood and or steel forms for all cast-in-place concrete.

.4 Void forms between structural elements and soil below.

.5 Shoring, bracing, and anchorage.

.6 Form openings for other trades.

.7 Coordinate installation of concrete accessories.

.8 Set anchor bolts, anchors, sleeves, frames, and other items supplied by other trades.

.9 Clean erected formwork prior to concrete placement.

.10 Remove forms and supporting falsework.

1.2 Design Standards

.1 Design and detail forms and supporting falsework in accordance with the National Building Code of Canada (NBC), Canadian Standards Association CAN/CSA-A23.1-00, CSA S269.1, CAN/CSA S269-3, ACI 347R, and applicable construction safety regulations.

.2 Design to be done by a Professional Structural Engineer, registered in the Province of Manitoba.

1.3 Quality Assurance

.1 Construct and erect concrete formwork in accordance with CAN/CSA-A23.1-00, CAN/CSA S269.3, ACI 347R, and all applicable construction safety regulations for the place of Work.

2. PRODUCTS

2.1 Exposed Surfaces

.1 Square-edged, smooth surfaced panels true in plane, free of holes, surface markings, or defects.

2.2 Unexposed Surfaces

.1 Square-edged T&G lumber, plywood or other material, suitable to retain concrete without leakage or distortion.

2.3 Wood Materials

.1 Plywood: douglas fir, conforming to CSA O121-M solid one side, sheathing grade. Sound undamaged sheets with clean true edges.

.2 Lumber: conforming to CSA O141-M.

.3 Nails, Spikes and Staples: galvanized; conforming to CSA B111.

2.4 Prefabricated Forms

.1 Steel Type: minimum 1.6 mm steel thickness; well matched, tight fitting, and adequately stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.

.2 Tubular Column Type: round, spirally wound laminated fiber material, internally treated with release agent; sizes indicated on Drawings.

.3 Void Forms: moisture resistant treated paper faces; bio-degradable, structurally sufficient to support weight of wet concrete mix until initial set.

2.5 Accessories

.1 Plain Formliner: Zemdrain by Dupont or accepted alternate.

.2 Form Ties: removable snap-off metal type, galvanized, fixed length, minimum working strength of 13 kN when assembled. For water retaining structures use form ties that leave a minimum cutback of 50 mm. For non-water retaining structures use 25 mm deep plastic cone snap type or screw type on exposed surfaces. Wire ties are not permitted.

.3 Form Release Agent: colourless mineral oil which will not stain concrete or impair natural bonding or colour characteristics of coating intended for use on concrete.

.4 Corner or Chamfer Fillets: mill finished pine, 25 mm width, maximum possible lengths, mitre ends.

.5 Reglets: mill finished pine, shaped to required cross-section, maximum possible lengths, mitre ends.

.6 Sealing Tape: reinforced, self-adhesive, waterproof kraft.

3. EXECUTION

3.1 Examination

.1 Before starting this Work, examine Work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Erection

.1 Verify lines, levels, and centres before proceeding with formwork. Ensure dimensions agree with Drawings.

.2 Construct formwork and falsework to meet design and regulatory requirements, and to produce finished concrete conforming to surfaces, shapes, lines, and dimensions indicated on Drawings.

.3 Arrange and assemble formwork to permit removal without damage to concrete.

.4 Align joints and make watertight to prevent leakage of cement paste and disfiguration of concrete. Keep form joints to a minimum. Tape as necessary.

.5 Obtain Contract Administrator's permission for use of earth forms. When using earth forms, hand-trim sides and bottoms and remove loose material prior to placing concrete.

.6 Arrange forms to allow removal without removal of principal shores, where these are required to remain in place.

.7 Obtain Contract Administrator's acceptance before framing openings in concrete slabs, walls, beams, and columns not indicated on Drawings.

.8 Provide falsework to ensure stability of formwork. Prop or strengthen all previously constructed parts liable to be overstressed by construction loads.

.9 Position form joints to suit any expressed lines required in exposed concrete.

.10 Provide chamfer on all internal and external corners and edges of exposed concrete unless shown otherwise.

.11 Form chases, slots, openings, drips, and recesses as detailed on Drawings.

.12 Set screeds with top edge level to required elevations.

.13 Check and readjust formwork to required lines and levels during placing of concrete.

.14 Where construction joints are required in beams and suspended slabs, form joints at the one third point in the span unless shown or noted otherwise on Drawings.

.15 Provide reveals or reglets on construction joints as shown on the Drawings.

3.3 Tolerance

.1 Construct formwork to produce concrete with dimensions, lines, and levels within tolerances specified in ACI 347R, Guide to Formwork for Concrete.

.2 Camber slabs and beams 6 mm per 3 m of span unless otherwise indicated on Drawings. Review method of providing camber with Contract Administrator prior to proceeding. Maintain beam depth and slab thickness from cambered surface.

3.4 Inserts/Embedded Items/Openings

.1 Provide formed openings where required for pipes, conduits, sleeves, and other Work to be embedded in and passing through concrete members.

.2 Accurately locate and set in place items which are to be cast directly into concrete.

.3 Coordinate Work of other Sections and co-operate with trades involved in forming openings, slots, recesses, chases, and setting sleeves, bolts, anchors, and other inserts.

.4 Coordinate installation of concrete accessories specified in Section 03250.

.5 Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

.6 Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so no leakage occurs, and to provide uniform surface on exposed concrete.

3.5 Field Quality Control

.1 Inspect and check complete formwork, falsework, shoring, and bracing to ensure that Work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and parts are secure.

.2 Inform Contract Administrator when formwork is complete and has been cleaned, to allow for review. Contract Administrator's review will be for verification that earth bottoms are clean and that forms are clean and free from debris.

.3 Allow Contract Administrator to review each section of formwork prior to re-use. Formwork may be re-used if acceptable to the Contract Administrator.

3.6 Cleaning

.1 Clean forms as erection proceeds, to remove foreign matter. Remove cuttings, shavings, and debris from within forms. Flush completely with water to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

.2 During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within a heated enclosure. Use compressed air or other means to remove foreign matter.

3.7 Formwork Preparation

.1 Apply form release agent in accordance with Manufacturer's recommendations, prior to placing reinforcing steel, anchoring devices, and embedded parts.

.2 Do not apply form release agent where concrete surfaces are to receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces moist prior to placing concrete.

.3 Formliner shall be used on all interior wall surfaces of the channels and other water containing structures. It shall be installed in strict accordance with the Manufacturer's instructions. The Manufacturer's Representative shall be on-site at the beginning of the formliner installation and as required to ensure recommended procedures are followed. Wrinkles or folding of the formliner during concrete placement will not be accepted.

3.8 Form Removal

.1 Notify Contract Administrator prior to removing formwork.

.2 Do not remove forms and falsework until concrete has gained sufficient strength to carry its own weight, plus construction loads and design loads which are liable to be imposed. Verify strength of concrete by compression tests to satisfaction of Contract Administrator.

.3 Remove falsework progressively, in accordance with regulatory requirements and ensure that no shock loads or imbalanced loads are imposed on structure.

.4 Loosen forms carefully without damaging concrete surfaces. Do not apply tools to exposed concrete surfaces.

.5 Leave forms loosely in place for protection until curing requirements are complete.

END OF SECTION

CONCRETE REINFORCEMENT

1. GENERAL

1.1 Work Included

.1 Reinforcing steel bars, and welded steel wire fabric, for cast-in-place concrete, complete with tie wire.

.2 Support chairs, bolsters, bar supports and spacers, for reinforcing.

1.2 Quality Assurance

.1 Perform concrete reinforcing Work in accordance with Canadian Standards Association CAN/CSA-A23.1-00.

1.3 Inspection and Testing

.1 If requested by Contract Administrator, submit three (3) certified copies of mill test report of reinforcement supplied, indicating physical and chemical analysis.

1.4 Shop Drawings

.1 Submit bar lists and placing Drawings in accordance with Section 01300.

.2 Clearly indicate bar sizes, spacings, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, and supporting and spacing devices.

.3 Drawings and details to conform to CAN/CSA-A23.1-00, CAN/CSA-A23.3, and RSIC's Reinforcing Steel Manual of Standard Practice.

.4 Detail placement of reinforcing where special conditions occur.

.5 Detail lap lengths and bar development lengths to CAN/CSA-A23.1-00, unless otherwise shown on the Drawings.

1.5 Delivery and Storage

.1 Deliver, handle, and store reinforcement in a manner to prevent damage and contamination.

.2 Deliver bars in bundles, clearly identified in relation to bar lists.

2. PRODUCTS

2.1 Reinforcing Materials

.1 Reinforcing Steel: minimum 400 MPa yield grade; deformed billet steel bars conforming to CAN/CSA-G30.18; plain finish.

2.2 Accessory Materials

.1 Tie Wire: minimum 1.6 mm annealed type, or patented system accepted by Contract Administrator.

.2 Chairs, Bolsters, Bar Supports, Spacers: adequately sized for strength and support of reinforcing steel during construction.

.3 Bar Chairs for exposed surfaces: to be non-corrosive PVC chairs or concrete chairs purpose made. Steel bar chairs, galvanized bar chairs, concrete bricks, broken concrete blocks, or wood supports are not acceptable.

.4 Bar Chairs for non-exposed surfaces: concrete bricks are acceptable for support of bottom layer of bars for slabs on fill. Broken concrete blocks, stones, and wood supports are not acceptable.

.5 Threaded Couplers: conforming to CSA-A23.3, American Concrete Institute (ACI) 318, and ACI 349, complete with temporary cap, sizes as shown on Drawings, as manufactured by Bar Grip Canada or accepted alternate.

3. EXECUTION

3.1 Examination

.1 Before starting this Work, examine Work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Fabrication

.1 Fabricate reinforcing steel in accordance with CAN/CSA-A23.1-00 and Drawings.

.2 Locate reinforcing splices not indicated on Drawings at points of minimum stress.

.3 Fabricate within the following tolerances:

.1 Sheared length: plus 0, minus 25 mm.

.2 Depth of truss bars: plus 0, minus 10 mm.

.3 Stirrups, ties, and spirals: plus 0, minus 10 mm.

.4 Other bends: plus 0, minus 25 mm.

.4 All bending shall be done cold with a suitable machine accurately producing all lengths, depths and radii shown on the bending details.

.5 After initial fabrication, reinforcing steel shall not be rebent or straightened unless so indicated on the Drawings.

.6 Heating of reinforcing steel will not be permitted.

3.3 Installation

.1 Place reinforcing steel in accordance with reviewed placing Drawings and CAN/CSA-A23.1-00. Chair slab reinforcing not further apart than 1.2 m in either direction. Tie reinforcing steel at maximum spacing 600 mm.

.2 Adequately support reinforcing and secure against displacement within tolerances permitted.

.3 Place reinforcing steel to provide concrete cover required by CAN/CSA-A23.1-00, but not less than shown below or noted otherwise on Drawings:

Item	Coverage (mm)
Beam Stirrups	40
Slabs (top and bottom)	50
Column Ties	40
Walls	50
Concrete formed against earth	75

.4 Maintain alignment as follows:

Item	Tolerances (mm) Plus or Minus
Slabs	5
Other Structural Members	10
Rebar Bends and Ends	50

.5 Do not disturb or damage vapour barrier or void form while placing reinforcing steel.

3.4 Cleaning

.1 Ensure concrete reinforcing is clean and free from oil and deleterious matter.

.2 Remove all loose scale, loose rust, concrete from prior pours, and other deleterious matter from surfaces of reinforcing.

END OF SECTION

CONCRETE ACCESSORIES

1. GENERAL

1.1 Work Included

.1 Curing and Sealing Compound.

.2 Joint Sealants.

.3 Joint Filler.

.4 PVC Waterstops.

.5 Expansive Waterstop.

.6 Epoxy grout.

.7 Non-ferrous Grout.

.8 Latex Patching Agent.

.9 Epoxy Bonding Agent.

.10 Curing Compound.

.11 Moisture Retention Film.

.12 Pre-moulded Expansion Joint Filler.

.13 Fasteners.

2. PRODUCTS

2.1 Materials

.1 Curing and Sealing Compounds: Master Builders Masterseal, Sika Florseal, or accepted alternate.

.2 Joint Sealants: Non-staining, non-sagging, grey two (2)-part polysulphide liquid polymer base or a two (2)-part polyurethane base such as Sikaflex 2c NS/SL or Vulkem 245 for horizontal and vertical joints with compatible primer as per sealant Manufacturer's requirements.

.3 Joint Filler: Closed cell polyurethane.

.4 PVC Waterstops: Conforming to CGSB 41-6P-35M polyvinylchloride, sizes indicated on Drawings, split bulb, welded mitred tees, crosses, and L's. Minimum

service movement 20 mm. Acceptable Manufacturers are Sika Durajoint, W. R. Meadows, Sealtight, B. F. Goodrich, and Greenstreak. Submit proposed Product for review.

.5 Expansive Waterstop: SikaSwell S by Sika or accepted alternate.

.6 Epoxy grout: Sika Talygrout, CPD Epoxy Grout, or accepted alternate.

.7 Non-ferrous Grout: Pre-mixed, non-shrink, Master Builders 713, Sika M-Bed, CPD Non-Shrink Grout, Steel C1 Grout, minimum 35 MPa compressive strength.

.8 Latex Patching Agent: Daraweld-C Latex Bonding Agent, or accepted alternate.

.9 Epoxy Bonding Agent: Master Builders Concresive 1001 LPL, Dural Duralbond, Sikadur 32 HI-bond, or accepted alternate.

.10 Curing Compound: conforming to American Society for Testing and Materials (ASTM) C309.

.11 Moisture Retention Film: Master Builders Confilm or accepted alternate.

.12 Pre-moulded Expansion Joint Filler: asphalt impregnated vegetable or cane fibreboard, conforming to ASTM D1751, sizes indicated on Drawings, such as W. R. Meadows Sealtight Fibre Expansion Joint, and Sika Flexcell.

.13 Fasteners: fasteners (all nuts, bolts, washers, screws, etc.) stainless steel for all aluminum items, conforming to ASTM 304 or 316, sizes and locations as required by item Manufacturer.

3. EXECUTION

3.1 Installation

.1 Coordinate Work of this Section with other construction.

.2 Install all concrete accessories in accordance with Drawings and Manufacturer's recommendations and ensure compatibility. Install straight, level, and plumb.

.3 Ensure items are not disturbed during concrete placement.

.4 Curing and sealing compounds are to be used for curing purposes of all concrete where practical or compatible with finishes. Main floor of the building shall be moist cured as per Section 03300.

.5 Joint sealant shall be applied per Manufacturer's instructions. If joint surfaces are damp, dry and apply primer as recommended by Manufacturer. Apply polyethylene debonding tape as indicated on the Drawings.

.6 Joint Filler: install joint filler in expansion joints as indicated on Drawings.

.7 PVC Waterstop:

.1 Install PVC split bulb waterstop in expansion joints as indicated on Drawings.

.2 All joints other than straight butt joints shall be plant fabricated by the waterstop Supplier.

.3 Install waterstop continuous without displacing reinforcement. Butt weld splices too Manufacturer's directions. Secure in place to prevent dislodgment during placing of concrete. All filed splices to be heat-fused and tested for complete seals by use of a corona discharge unit. Costs for testing to paid for by Contractor. Secure in place in accordance with Manufacturer's instructions, but at spacings no greater than 300 mm.

.4 Take particular care to correctly position the waterstop during installation. Make adequate provisions to support the waterstop during the progress of the Work and to ensure proper embedment, symmetrical about the joint. Fully compact the concrete in the region of the waterstop during the placing of the concrete.

.5 Do not place concrete until waterstop has been reviewed by the Contract Administrator.

.8 Expansive Waterstop:

.1 Apply expansive waterstop in all construction joints of subsurface and water containing structures.

.2 Apply as per Manufacturer's instructions to clean surfaces free from any loose materials.

.3 Protect expansive waterstop from contact with water prior to concrete placement. Replace waterstop if it has come in contact with water and has begun to absorb water.

.9 Latex Patching Agent is to be used for patching formed concrete surfaces where required.

.10 Epoxy Bonding Agent is to be used to bond new concrete to existing concrete surfaces.

END OF SECTION

CAST-IN-PLACE CONCRETE

1. GENERAL

1.1 Work Included

.1 All plain and reinforced cast-in-place concrete shown on the Drawings.

.2 Concrete required for ultraviolet (UV) equipment installation.

.3 Setting anchors, inserts, frames, sleeves, and other items supplied by other Sections.

.4 Repairing concrete imperfections.

.5 Finishing formed concrete surfaces.

.6 Finishing slab surfaces.

.7 Curing of concrete.

1.2 Quality Assurance

.1 Cast-in-place concrete to conform to Canadian Standards Association CAN/CSA-A23.1-00.

.2 Testing shall conform to CAN/CSA-A23.2-00.

.3 These standards shall be available in the Contractor's Site office for the use of the Contractor, sub-trades, and Contract Administrator.

1.3 Qualification

.1 Concrete flatwork finishing is to be done by an established firm having at least five (5) years of proven, satisfactory experience in this trade and employing skilled personnel.

.2 Submit proof of qualifications in writing to the Contract Administrator.

1.4 Inspection & Testing

.1 Notify the Contract Administrator at least forty-eight (48) hours before complete formwork and concrete reinforcement is ready for review. Reinforcing in walls shall be reviewed prior to closing forms.

.2 Allow ample time for notification, review, and corrective Work, if required, before scheduling concrete placement.

.3 Concrete sampling, inspection, and testing is to be performed by a CSA certified inspection and testing firm appointed and paid for by the City.

.4 Provide unencumbered access to all portions of Work and cooperate with appointed firm.

.5 Submit proposed mix design of each class of concrete to the Contract Administrator for review two (2) weeks prior to commencement of the Work.

.6 Tests of cement and aggregates may be performed to ensure conformance with requirements stated herein.

.7 Notify the Contract Administrator at least twenty-four (24) hours in advance of any concrete placement.

.8 Three (3) concrete test cylinders will be taken for every 50 or less cubic meters of each class of concrete placed.

.9 At least three test cylinders will be taken daily for each class of concrete placed.

.10 One (1) slump test and one air content test will be taken for each set of test cylinders taken.

.11 Additional slump and air content tests may be taken as necessary to verify quality of concrete.

.12 Testing of concrete will be performed in accordance with CAN/CSA-A23.2-00. Test results will be issued to the Contractor, the Contract Administrator, and the City.

.13 The Contractor is to pay costs for required retesting due to defective materials or workmanship.

.14 If accepted by the Contract Administrator, the Contractor may arrange and pay for additional tests for use as evidence to expedite construction.

.15 Strength requirements:

.1 To conform to the strength requirements of this Specification, the results of tests performed on laboratory cured cylinders for each class of concrete shall meet the requirements of Clause 17.6 of CAN/CSA-A23.1-00.

.2 If the strength requirements are not met the Contract Administrator shall have the right to require one or more of the following, all costs of which will be the responsibility of the Contractor:

.1 Changes in the mix proportions of the remainder of the Work.

.2 Additional curing on those portions of the structure represented by the test specimens that failed and cores drilled and tested in accordance with CAN/CSA-A23.2-00; the strengths shall be indicative of the strength of the in-place concrete.

.3 Load testing of the structural elements.

.3 After the completion of the testing procedure, if the Contract Administrator is not satisfied with the indicated quality of the concrete in the structure, the Contractor may be required to strengthen or replace those portions which he deems to be unsatisfactory.

2. PRODUCTS

2.1 Concrete Materials

.1 Cement: Normal Type 10 and Type 50 Portland Cement conforming to CSA-A5.

.2 Fine Aggregate: Conforming to Normal Density Fine Aggregate, CAN/CSA-23.1-00. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to normal Density Fine Aggregate, CAN/CSA-A23.1-00, Table 4 and Table 6.

.3 Coarse Aggregate: Conforming to Normal Density Coarse Aggregate, CAN/CSA-23.1-00, Group I, 20-5 mm and 10 to 2.5 mm. If requested by the Contract Administrator, submit evidence at least two (2) weeks before use in concrete mix showing conformance to normal Density Coarse Aggregate, CAN/CSA-A23.1-00, Table 5 and Table 6.

.4 Ensure that no aggregates are used that may undergo volume change due to alkali reactivity, moisture retention, or other causes. Confirm suitability of aggregate with a petrographic analysis if deemed necessary by the Contract Administrator.

.5 Water: Potable, clean, and free from injurious amounts of oil, alkali, organic matter, or other deleterious matter.

.6 Materials are to be obtained from the same source of supply or Manufacturer for the duration of the project.

.7 Pozzolans: Type C fly ash, conforming to CSA-A23.5, source of material to be acceptable to the Contract Administrator.

2.2 Admixtures

.1 Air entrainment: conforming to American Society for Testing and Materials (ASTM) Standard C260.

.2 Chemical Admixtures: conforming to ASTM Standard C494.

.3 Calcium chloride or admixtures containing calcium chloride shall not be used in concrete.

2.3 Concrete Mixes

.1 Pay all costs for mix design. Submit mix design to the Contract Administrator for review a minimum of two (2) weeks prior to concrete pour.

.2 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00.

.3 Provide concrete mixed in accordance with requirements of CAN/CSA-A23.1-00 and Table A (see below in this Section). Table A requirements shall govern where there is a difference between Table A and CAN/CSA-A23.1-00, Tables 6 to 10 requirements.

.4 Maximum allowable substitution of cement with fly ash material shall be 15% by weight when acceptable to the Contract Administrator.

.5 Use accelerating admixtures in cold weather only when accepted by the Contract Administrator. If accepted, the use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.

.6 Use set-retarding admixtures during hot weather only when accepted by the Contract Administrator.

.7 All admixtures must be compatible within the mix. Concrete with freezing and thawing exposure must satisfy the durability requirements of CAN/CSA-A23.1-00, Sections 14 and 15.

.8 All admixtures are subject to acceptance by the Contract Administrator. List all proposed admixtures in mix design submission. Do not change or add admixtures to accepted design mixes without the Contract Administrator's acceptance.

.9 The water:cementing ratio must be calculated and shown based on all available mixing water excluding aggregate absorption.

.10 Concrete delivered to Site must be accompanied by a delivery slip indicating time of completion of mixing, design strength of concrete, air content, and actual water-cement ratio.

Mix Type	Portion of Structure	Min. Compressive Strength @ 28 Days (MPa)	Cement Type	Min. Cement Content (kg/m^3)	Max. Water Cement Ratio	Nominal Aggregate Size (mm)	Slump (mm) Max./ Min.	Air Content (%)
1.	Water retaining structural concrete – slabs, walls, pipe supports	32	50	335	0.42	20 to 5	65 ± 25	5 to 8
2.	Non-water retaining structural concrete in contact with soil or exposed to weather – grade beams, exterior pads	32	50	--	0.45	20 to 5	80 ± 30	4 to 7
3.	Interior structural concrete – slabs	30	10	--	0.55	20 to 5	80 ± 30	--
4.	Miscellaneous concrete - curbs, equipment bases, pipe supports, benching	25	10	--	0.55	20 to 5	80 ± 30	--
5.	Masonry fill concrete	20	10	--	--	10 to 2.5	150 ± 30	--
6.	Stabilized fill concrete	10	50	--	--	Max. 40	--	--

3. EXECUTION

3.1 Examination

.1 Before starting this Work examine Work done by others which affects this Work.

.2 Notify the Contract Administrator of any conditions that would prejudice proper completion of this Work.

.3 Commencement of Work implies acceptance of existing conditions.

3.2 Placing Concrete

.1 Place concrete in accordance with requirements of CAN/CSA-A23.1-00 and as indicated on the Drawings. Layout of the Work and accuracy of same is the Contractor's sole responsibility.

.2 Notify the Contract Administrator a minimum of twenty-four (24) hours prior to pouring concrete. Under no circumstances pour concrete without notifying Contract Administrator, or in his absence, arranging for review of the Work and sampling of concrete.

.3 The concrete shall be placed rapidly and evenly as near to its final position as possible to reduce the risk of segregation, flowlines, and cold joints. Concrete shall be placed within 1½ hours of mixing.

.4 Ensure all anchor bolts, seats, plates, and other items to be cast into concrete are securely placed and will not interfere with concrete placement.

.5 Before placing concrete all equipment for transporting the concrete shall be cleaned of hardened concrete and foreign materials.

.6 Immediately before concrete is placed, Contractor shall carefully inspect all forms to ensure that they are properly placed, sufficiently rigid and tight, and that all reinforcing steel and embedded parts are in the correct position and secured against movement during the placing operation. All forms shall be thoroughly cleaned and material removed.

.7 Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods, which will prevent the separation or loss of the ingredients. Concrete shall be deposited in the forms as nearly as practicable in its final position to avoid re-handling or flowing. Vibrators shall not be used to move concrete. Under no circumstances shall the concrete, which has partially hardened, be deposited in the forms.

.8 Concrete shall be thoroughly compacted by mechanical vibrators during placing operations. It shall be thoroughly worked around the reinforcement, embedded fixtures, and into the corners of the forms.

.9 Vibrate concrete using the appropriate size equipment as placing proceeds, in accordance with CAN/CSA-A23.1-00. Check frequency and amplitude of vibrations prior to use. Provide additional standby vibrators in the event of equipment failure.

.10 Prepare set or existing concrete by removing all laitance and loose or unsound materials and apply bonding agent in accordance with Manufacturer's recommendations.

.11 Where placing operations would involve dropping the concrete more than 1,500 mm, it shall be placed through canvas hoses or galvanized iron chutes. Concrete shall not be raised at a rate greater than that for which proper vibration may be affected.

.12 In locations where new concrete is dowelled to existing concrete, drill holes in existing concrete, insert steel dowels, and pack solidly with non-shrink grout.

.13 A minimum of three (3) days shall elapse between adjacent pours separated by construction joints or expansion joints.

.14 Do not place concrete if carbon dioxide producing equipment has been in operation in the building during the twelve (12) hours preceding the pour. This equipment shall not be used during placing or for twenty-four (24) hours after placing. During placing and curing concrete, surfaces shall be protected by formwork or an impermeable membrane from direct exposure to carbon dioxide, combustion gases, or drying from heaters.

.15 Honeycomb or embedded debris is not acceptable.

.16 Remove and replace defective concrete.

.17 Maintain accurate records of cast-in-place concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.3 Cold Weather Concreting

.1 The requirements of this section shall be applied to all concreting operations during cold weather, i.e., if the mean daily temperature falls below 5°C during placing or curing.

.2 Supplementary equipment as required below shall be at the job Site if concrete is likely to be placed in cold weather.

.3 Formwork and reinforcing steel shall be heated to at least 5°C before concrete is placed.

.4 The temperature of the concrete shall be maintained at not less than 10°C for seven (7) days. The concrete shall be kept above freezing temperature for at least a period of seven (7) days. In no case, shall the heating be removed until the concrete has reached a minimum compressive strength which will be specified by the Contract Administrator as determined from compressive strength tests on specimens cured under the same conditions as the concrete Works in question.

.5 Aggregates shall be heated to a temperature of not less that 20°C and not more than 65°C. Water shall be heated to a temperature between 55°C and 65°C. The temperature of the concrete at the time of placing in the forms shall be within the range specified in CAN/CSA-A23.1-00 for the thickness of the Section being placed.

.6 When the mean daily temperature may fall below 5°C, a complete housing of the Work, together with supplementary heat, shall be provided.

.7 Combustion-type heaters may be used if their exhaust gases are vented outside the enclosures and not allowed to come into contact with concrete surfaces. Fire extinguishers must be readily at hand wherever combustion-type heaters are used.

.8 When the ambient temperature is below -15°C, the housing shall be constructed so as to allow the concrete to be placed without the housing having to be opened. If the mixing is done outside of the housing, the concrete shall be placed by means of hoppers installed through the housing. The hoppers are to be plugged when not in use.

.9 When the ambient temperature is equal to or above -15°C, the Contractor will be permitted to open small portions of the housing for a limited time to facilitate the placing of the concrete.

.10 Refer to Section 01500 for temporary enclosure and heating requirements.

.11 Before depositing any of the concrete, the Contractor shall show that enough heating equipment is available to keep the air temperature surrounding the forms within the specified range. This shall be accomplished by bringing the temperature inside of the housing to the specified 20°C at least twelve (12) hours prior to the start of the concrete placing.

.12 The Contractor shall supply all required heating apparatuses and the necessary fuel. When dry heat is used, a means of maintaining atmospheric moisture shall be provided.

.13 Sufficient standby heating equipment must be available to allow for any sudden drop in outside temperatures and any breakdowns which may occur in the equipment.

.14 The Contractor shall keep a curing record of each concrete pour. The curing record shall include date and location of the pour, mean daily temperature, temperatures above and below the concrete within the enclosures, temperatures of the concrete surface at several points, and notes regarding the type of heating, enclosure, unusual weather conditions, etc. This record shall be available for review by the Contract Administrator at all times, and shall be turned over to the Contract Administrator at the end of the concreting operations.

3.4 Hot Weather Concreting

.1 General

.1 The requirements of this section shall be applied during hot weather, i.e., air temperatures above 25°C during placing.

.2 Concrete shall be placed at as low a temperature as possible, preferably below 15°C, but not above 27°C. Aggregate stockpiles may be cooled by water sprays and sun shades.

.3 Ice may be substituted for a portion of the mixing water provided the ice has melted by the time mixing is completed.

.4 Form and conveying equipment shall be kept as cool as possible before concreting by shading them from the sun, painting their surfaces white, and/or the use of water sprays.

.5 Sun shades and wind breaks shall be used as required during placing and finishing.

.6 Work shall be planned so that concrete can be placed as quickly as possible to avoid “cold joints”.

.7 The Contract Administrator's acceptance is necessary before the Contractor may use admixtures such as retardants to delay setting, or water-reducing agents to maintain workability and strength, and these are to be included in the mix designs submitted to the Contract Administrator.

.8 Curing shall follow immediately after the finishing operation.

.2 Hot-Weather Curing

.1 When the air temperature is at or above 25°C, curing shall be accomplished by water or by using saturated absorptive fabric, in order to achieve cooling by evaporation. Mass concrete shall be water cured for the basic curing period when the air temperature is at or above 20°C, in order to minimize the temperature rise of the concrete.

.3 Job Preparation

.1 When the air temperature is at or above 25°C, or when there is the probability of its rising to 25°C during the placing period, facilities shall be provided for protection of the concrete in place from the effects of hot and/or drying weather conditions. Under severe drying conditions, as defined in Clause 3.4.5.2 of this Specification Section, the formwork, reinforcement, and concreting equipment shall be protected from the direct rays of the sun or cooled by fogging and evaporation.

.4 Concrete Temperature

.1 The temperature of the concrete as placed shall be as low as practicable and in no case greater than that shown below for the indicated size of the concrete section.

Thickness of Section (m)	**Temperatures (°C)**	
	Minimum	**Maximum**
less than 0.3	10	27
0.3 – 1	10	27
1.2	5	25

.5 Protection from Drying

.1 Moderate Drying Conditions

.1 When surface moisture evaporation exceeds 0.75 $kg/m^2/h$, windbreaks shall be erected around the sides of the structural element.

.2 Severe Drying Conditions

.1 When surface moisture evaporation exceeds 1.0 kg/m^2/h, additional measure shall be taken to prevent rapid loss of moisture from the surface of the concrete. Such additional measures shall consist of the following:

.1 Erecting sunshades over the concrete during finishing and placing operations.

.2 Lowering the concrete temperature.

.3 Increasing humidity by applying fog spray immediately after placement and before finishing.

.4 Care shall be taken to prevent accumulation of water that may reduce the quality of the cement paste.

.5 Beginning the concrete curing immediately after trowelling.

.3 Surface Moisture Evaporation Rate

.1 The monograph, Figure D1, Appendix D of CAN/CSA-A23.1-00 shall be used to estimate surface moisture evaporation rates.

3.5 Concrete Protection for Reinforcement

.1 Ensure reinforcement is placed to provide minimum concrete cover in accordance with Section 03200 of these Specifications.

3.6 Construction Tolerance

.1 The Work shall be carefully and accurately set out; true to the positioning, levels, slopes, and dimensions shown on the Drawings and conforming to Sections 03100 and 03200.

.1 Sizes of Member or Thickness of Slabs: +6 mm - 0 mm.

.2 Cover of Concrete over Reinforcement: ±3 mm.

.3 Variations from Plumb: 6 mm in 3.0 m, 10 mm maximum.

.4 Variations from Flat: 3 mm in 3.0 m, 6 mm maximum.

.2 If these tolerances are exceeded the Contractor may, at the discretion of the Contract Administrator, be required to remove and replace or to modify the placed concrete before acceptance. The costs incurred by the Contract Administrator for such

investigation, testing, or review of reconstruction and the cost of reconstruction shall be borne by the Contractor.

3.7 Finishing Slab Surfaces

.1 Finish all slab surfaces conforming to CAN/CSA-A23.1-00, Clause 22 and as specified below.

.2 Bull Floating

.1 Flatness for suspended concrete slabs to be achieved by means of hiway straight edge (minimum 3 m width) in lieu of standard bull float. Immediately after screeding, bull float floor surfaces to remove ridges and fill voids.

.2 Complete bull floating before any excess moisture or bleed water is visible on surface.

.3 Mechanical Floating

.1 Mechanical float floor surfaces when bleed water has disappeared and surfaces are sufficiently hard to prevent working excess mortar to surface.

.2 Continue floating as necessary to produce surfaces of uniform texture, free from hollows, bumps and screed marks.

.3 For surfaces to be trowelled, continue floating as necessary to embed coarse aggregate particles firmly below surface mortar.

.4 Hand float in restricted areas, corners, etc.

.4 Trowelling

.1 Trowel floor surfaces with mechanical trowelling machines fitted with steel blades.

.2 Commence trowelling when surfaces are sufficiently hard to prevent working excess fine material to surface.

.3 Perform additional trowelling at intervals so final trowelling is done just before concrete becomes so hard that further trowelling is ineffective.

.4 Finish trowelled surfaces to be hard, dense, and free from blemishes and other imperfections.

.5 Hand trowel in restricted areas, corners, around cast-in items, etc.

.6 Cure concrete as specified.

.7 Protect all floors from damage during construction.

.5 Coating

.1 Refer to Section 09730 for coating of floor surfaces.

3.8 Curing and Protection

.1 Cure and protect freshly placed concrete in accordance with Clause 21 of CAN/CSA-A23.1-00.

.2 All concrete shall receive moist curing for a period of at least seven (7) days. One (1) of the following methods shall be used as soon as the concrete has hardened sufficiently to prevent marring:

.1 Surface covered with canvas or other satisfactory material and kept thoroughly wet.

.2 Surface sealed with polyethylene sheeting at least 0.15 mm thick and the concrete kept thoroughly wet.

.3 Subject to the acceptance of the Contract Administrator or as specified, a liquid, membrane forming, curing compound supplied at the rate recommended by the Manufacturer may be used. Curing compounds shall not be used on a surface where bond is required for the finishes.

.4 Surfaces of concrete, which are protected by formwork, which is left in place for seven (7) days, shall not require any additional curing (except as specified for hot weather). If the formwork is removed in less than seven (7) days, the concrete shall receive a moist curing as above or until seven (7) days have elapsed since the concrete was placed, whichever occurs first.

.3 No concreting will be allowed until all materials required for the curing phase are on Site and ready for use.

.4 At the end of the curing and protection period, the temperature of the concrete shall be reduced gradually at a rate not exceeding 10°C per day until the outside air temperature has been reached.

.5 Concrete that is allowed to freeze or attain insufficient curing conditions shall be subject to all necessary investigations and testing as deemed necessary by the Contract Administrator and all such concrete shall be removed and the portion reconstructed as directed by the Contract Administrator, at Contractor’s cost.

3.9 Formed Concrete

.1 Allow the Contract Administrator to review concrete surfaces immediately upon removal of the forms.

.2 Any imperfect joints, voids, stone pockets or other defective areas and tie holes, as specified, shall at once be patched before the concrete is thoroughly dry. Defective areas shall be chipped away to a depth of not less than 40 mm with the edges perpendicular to the surface. The area to be patched and a space at least 150 mm wide entirely surrounding it shall be wetted to prevent absorption of water from the patching mortar.

.3 The patch shall be made of the same material and of the same proportions as used for the concrete except that the coarse aggregate shall be omitted, and cement added to match the colour of the surrounding concrete. The amount of mixing water shall be as little as is consistent with the requirements.

.4 Modify or replace concrete not conforming to qualities, lines, details and elevations specified herein or indicated on the Drawings to the acceptance of the Contract Administrator.

3.10 Finishing Formed Surfaces

.1 Interior formed concrete surfaces.

.1 Walls of water retaining structures to receive form liner finish as per Section 03100.

.2 Finish exposed surfaces to Smooth Rubbed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.7.2.

.3 Finish non-exposed surfaces to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

.2 Exterior formed concrete surfaces.

.1 Surfaces to receive insulation and/or roofing material are to be finished to Smooth-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.6.

.2 Other surfaces to be finished to Rough-Formed Finish conforming to CAN/CSA-A23.1-00, Clause 24.3.5.

3.11 Equipment Pads, Pipe Supports, and Cast in Metal Frames

.1 Provide concrete pads and supports for equipment and pipes where and as indicated on Drawings. Adjust dimensions to reviewed equipment Shop Drawings.

.2 Insert bolts and sleeves and pack solidly with non-shrink grout, in accordance with setting details and templates.

.3 Steel trowel surface smooth. Chamfer exposed horizontal and vertical edges.

.4 Clean excess concrete from metal frames, inserts, weld plates, etc. Clean and tool concrete around the above noted items.

3.12 Grouting

.1 Grout all miscellaneous anchor bolts with non-ferrous or epoxy grout as specified using templates for accurate positioning.

.2 Grout between pipes and pipe supports as required to provide continuous support over the entire contact area.

.3 Grout under base plates and other items as required and shown on the Drawings.

.4 Grout dowels to existing concrete as indicated on the Drawings.

3.13 Defective Concrete

.1 Concrete not meeting the requirements of the Specifications and Drawings shall be considered defective concrete.

.2 Concrete not conforming to the lines, details, and grade specified herein or as shown on the Drawings shall be modified or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator. Finished lines, dimensions, and surfaces shall be correct and true within tolerances specified herein and in the Formwork Section of these Specifications.

.3 Concrete not properly placed resulting in honeycombing and other defects shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

.4 To conform to the strength requirements, the average of all tests shall exceed the specified strength. When three (3) or more tests of the same class of concrete are available, the average of any three (3) consecutive tests shall be equal to, or greater than the specified strength, and no strength test shall fall more than 3.5 MPa below the specified strength. If any of the criteria of the above clause are not met, the Contract Administrator shall have the right to require one or more of the following:

.1 Changes in mix proportions for the remainder of the Work.

.2 Cores drilled and tested from the areas in question as directed by the Contract Administrator and in accordance with CAN/CSA-A23.2-00. The test results shall be indicative of the strength of the in-place concrete.

.3 Load testing of the structural elements.

.4 The changes in the mix proportions, cores drilled and tested, and load testing shall be at the Contractor's expense.

.5 Concrete failing to meet the strength requirements of this Specification shall be strengthened or replaced at the Contractor's expense and to the satisfaction of the Contract Administrator.

3.14 Patching

.1 Allow Contract Administrator to review concrete surfaces immediately upon removal of all formwork.

.2 Patch imperfections when concrete is green.

.3 Remove all exposed metal form ties, nails and wires, break off fins, and remove all loose concrete.

.4 Thoroughly wet all form tie holes and patch with patching mortar followed by proper curing.

.5 Chip away honeycombed and other defective surfaces to depth of not less than 25 mm with the edges perpendicular to the surface. Thoroughly wet and patch with patching mortar followed by proper curing.

3.15 Watertightness Testing

.1 The structures shall be watertight and all precautions shall be taken, especially joint treatment, to construct watertight structures.

.2 Notify the Contract Administrator at least two (2) working days before commencing the watertightness test.

.3 All water retaining structures shall be watertight. The structures, when full, shall be reviewed over a forty-eight (48) hour period for leakage including monitoring of visible leaks and testing for leaks by measurement.

.4 Filling the structures in preparation of the watertightness test shall be performed only after the wall and floor concrete has attained 100% of the design strength and the roof has obtained 75% of the design strength. Fill the tanks with clean water forty-

eight (48) hours prior to the watertightness test to allow for full saturation of the concrete.

.5 All water used for testing shall be supplied as outlined in Section 01500. The supply (both quantity and time of supply) of water for the watertightness test shall be subject to control of the City and prior arrangements shall be made by the Contractor with the City for its supply.

.6 The Contractor shall measure leakage during next forty-eight (48) hour period. The measurements shall be witnessed by the Contract Administrator. With the water at maximum operating level for forty-eight (48) hours, there shall be no visible moisture or wetness on areas that will be seen or backfilled and the leakage measured over a period of twenty-four (24) hours shall not exceed 0.10% of the water volume in the test period.

.7 Locate and repair all leaks until all leakage is remedied and repeat the forty-eight (48) hour watertightness test following each repair operation, at no additional cost to the City.

.8 All water used for retesting shall be supplied at the Contractor's expense. The City shall supply the water as outlined above in Paragraph 3.15.5. Disposal of the water for the initial test and all retests shall be at the Contractor's expense.

3.16 Clean-Up

.1 As Work progresses and at the completion of Work, remove from Site all debris, excess materials, and equipment.

END OF SECTION

TABLE OF CONTENTS

DIVISION 04

Reviewed and Approved

Date

MASONRY PROCEDURES

1. GENERAL

1.1 Work Included

.1 Masonry Work is described in Division 4.

1.2 References

.1 Canadian Standards Association (CSA) A179 Mortar and Grout for Unit Masonry.

.2 CSA 3-A371 Masonry Construction for Buildings.

1.3 Source Quality Control

.1 Submit laboratory test reports in accordance with Section 01300.

.2 Submit laboratory test reports certifying compliance of masonry units and mortar ingredients with Specification requirements.

1.4 Samples

.1 If requested by the Contract Administrator, submit samples in accordance with Section 01300.

.2 Submit samples:

.1 Two (2) of each type of masonry unit specified.

.2 One (1) of each type of masonry accessory specified.

.3 One (1) of each type of masonry reinforcement and tie proposed for use.

.4 As required for testing purposes.

1.5 Product Delivery, Storage, and Handling

.1 Deliver materials to job Site in dry condition.

.2 Keep materials dry until use, except where wetting of bricks is specified.

.3 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.

1.6 Cold Weather Requirements

.1 Supplement Clause 5.15 of CSA A371 with the following requirements:

.1 Maintain temperature of mortar between 5ºC and 50ºC until batch used.

1.7 Hot Weather Requirements

.1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.

1.8 Protection

.1 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry Work is completed and protected by flashings or other permanent construction.

.2 Protect masonry and other Work from marking and other damage. Protect completed Work from mortar droppings. Use non-staining coverings.

.3 Provide temporary bracing of masonry Work during and after erection until permanent lateral support is in place.

2. PRODUCTS

2.1 Materials

.1 Masonry materials are specified in related Sections indicated in 1.1.

3. EXECUTION

3.1 Workmanship

.1 Do masonry Work in accordance with CSA A371 except where specified otherwise.

.2 Build masonry plumb, level, and true to line, with vertical joints in alignment.

.3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.2 Tolerances

.1 Tolerances in notes to Clause 5.3 of CSA A371 apply.

3.3 Exposed Masonry

.1 Remove chipped, cracked, and otherwise damaged units in exposed masonry and replace with undamaged units.

3.4 Jointing

.1 Allow joints to set just enough to remove excess water, then tool with round joints to provide smooth, compressed, uniformly concave joints where concave joints are indicated.

.2 Strike flush all joints concealed in walls and joints in walls to receive plaster, tile, insulation, or other applied material except paint or similar thin finish coating.

3.5 Cutting

.1 Cut out neatly for electrical switches, outlet boxes, and other recessed or built-in objects.

.2 Make cuts straight, clean, and free from uneven edges.

3.6 Building-In

.1 Build in items required to be built into masonry.

.2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as Work progresses.

.3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.

3.7 Parging

.1 Use parging mortar specified in Section 04100 - Mortar and Grout for Masonry.

.2 Apply parging in uniform coating not less than 10 mm thick, where indicated.

3.8 Support Of Loads

.1 Use concrete to Section 03300 - Cast-in-Place Concrete, where concrete fill is used in lieu of solid units.

.2 Use grout to CSA A179 where grout is used in lieu of solid units.

.3 Install building paper below voids to be filled with concrete or grout; keep paper 25 mm back from faces of units.

3.9 Provision For Movement

.1 Leave 40 mm space between top of non-load bearing walls and partitions and structural elements. Do not use wedges.

.2 Built masonry to tie in with stabilizers, with provision for vertical movement.

3.10 Control Joints

.1 Construct continuous control joints as indicated on the Drawings.

3.11 Expansion Joints

.1 Build-in continuous expansion joints as indicated.

3.12 Field Quality Control

.1 Inspection and testing will be carried out by a testing laboratory designated by Contract Administrator.

.2 The City will pay costs for testing.

.3 Costs for additional testing required as a result of defective materials will be the responsibility of the Contractor.

END OF SECTION

MORTAR AND GROUT FOR MASONRY

1. GENERAL

1.1 Work Included

.1 Provide all materials and labour to perform the mortar and grout Work for all masonry walls indicated on the Drawings.

1.2 References

.1 CSA A179 Mortar and Grout for Unit Masonry.

1.3 Samples

.1 Submit samples in accordance with Section 01300.

2. PRODUCTS

2.1 Materials

.1 Mortar and grout: conforming to Canadian Standards Association (CSA) A179.

.2 Aggregate: conforming to CSA A82.56.

.3 Water: clean, potable, free of injurious amounts of acids, alkalies, and organic material.

.4 Masonry cement: conforming to CAN/CSA-A8, Type H.

.5 Portland cement: conforming to CAN/CSA-A5, normal (Type 10).

.6 Hydrated Lime: conforming to CSA A82.43.

.7 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.

.8 Dirt resistant additives: aluminum tristearate, calcium stearate, or ammonium stearate.

2.2 Material Source

.1 Use same brands of materials and source of aggregate for entire project.

2.3 Mortar Types

.1 Mortar for all masonry:

.1 Type S based on Property Specifications.

2.4 Grout

.1 Grout: to CSA A179, Table 3.

2.5 Parging

.1 Parging mortar: Type S to CSA A179.

3. EXECUTION

3.1 Mixing

.1 Do masonry mortar and grout Work in accordance with CSA A179 except where specified otherwise.

.2 Mix grout to semi-fluid consistency.

.3 Incorporate admixtures into mixes in accordance with Manufacturer's instructions.

.4 Comply with cold weather requirements specified in CSA A371 Masonry Construction for Buildings.

3.2 Testing

.1 Testing of mortar materials will be carried out by an inspection and testing firm designated by Contract Administrator.

.2 The City will pay costs for tests.

.3 Costs for additional testing required as a result of defective materials will be the responsibility of the Contractor.

.4 Submit samples of all materials proposed for testing.

END OF SECTION

MASONRY REINFORCEMENT, CONNECTORS AND ACCESSORIES

1. GENERAL

1.1 Work Included

.1 Supply all material and labour for the incorporation of the masonry reinforcement and connectors into the Work of this Contract.

1.2 References

.1 Canadian Standards Association (CAN/CSA) A23.1, Concrete Materials and Methods of Concrete Construction.

.2 CSA A370, Connectors for Masonry.

.3 CSA A371, Masonry Construction for Buildings.

.4 CSA G30.3, Cold-Drawn Steel Wire for Concrete Reinforcement.

.5 CAN/CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.

.6 CSA S304.1, Masonry Design for Buildings (Limit States Design).

.7 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.3 Source Quality Control

.1 If requested by the Contract Administrator, submit certified copy of mill test report of reinforcement steel and connectors, showing physical and chemical analysis, minimum five (5) weeks prior to commencing reinforcement Work.

.2 Inform the Contract Administrator of proposed source of material to be supplied.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Shop Drawings shall consist of bar bending details, lists, and placing Drawings.

.3 On placing Drawings, indicate sizes, spacing, location, and quantities of reinforcement and connectors.

2. PRODUCTS

2.1 Materials

.1 Bar reinforcement: to CSA A371 and CAN/CSA-G30.18, Grade 400.

.2 Wire reinforcement: to CSA A371 and CSA-G30.3, truss type.

.3 Connectors: to CSA A370 and CSA S304.1.

.4 Corrosion protection: to CSA S304.1, galvanized.

.5 Control joint filler: preformed rubber, neoprene, or polyvinyl chloride materials of size and shape indicated.

2.2 Fabrication

.1 Fabricate reinforcing in accordance with CSA A23.1.

.2 Fabricate connectors in accordance with CSA A370.

.3 Obtain the Contract Administrator's acceptance for locations of reinforcement splices other than shown on placing Drawings.

.4 Subject to review by the Contract Administrator, weld reinforcement in accordance with CSA W186.

.5 Ship reinforcement and connectors, clearly identified in accordance with the Drawings.

3. EXECUTION

3.1 General

.1 Do masonry connectors and reinforcement in accordance with CSA A370, CSA A371, CAN/CSA-A23.1 and CSA S304.1 unless indicated otherwise.

.2 Prior to placing concrete and mortar, obtain Contract Administrator's acceptance of placement of reinforcement and connectors.

.3 Do additional reinforcement of masonry as indicated.

3.2 Bonding and Tying

.1 Bond walls of two (2) or more wythes using metal connectors in accordance with National Building Code (NBC), CSA S304.1, CSA A371, and as indicated.

.2 Tie masonry veneer to backing in accordance with NBC, CSA S304.1, CSA A371, and as indicated.

.3 Block Shear Connector by FERO to be installed as shown on the Drawings.

3.3 Reinforced Lintels and Bond Beams

.1 Reinforce masonry lintels and bond beams as indicated.

.2 Place and grout reinforcement in accordance with CSA S304.1.

3.4 Grouting

.1 Grout masonry in accordance with CSA S304 and as indicated.

3.5 Metal Anchors

.1 Do metal anchors as indicated.

3.6 Lateral Support and Anchorage

.1 Do lateral support and anchorage in accordance with CSA S304.1 and as indicated.

3.7 Control Joints

.1 Terminate reinforcement 25 mm short of each side of control joints unless otherwise indicated.

.2 Install continuous control joint fillers in control joints.

3.8 Field Bending

.1 Do not field bend reinforcement and connectors except where indicated or authorized by Contract Administrator.

.2 When field bending is authorized, bend without heat, applying a slow and steady pressure.

.3 Replace bars and connectors which develop cracks or splits.

END OF SECTION

CLAYBRICK MASONRY

1. GENERAL

1.1 Related Documents

.1 Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to Work of this Section.

1.2 Description of Work

.1 Extend of each type of masonry Work is indicated on Drawings and schedule.

.2 Types of masonry Work required include:

.1 Brick Masonry.

1.3 Related Work

.1 Install Work furnished under other Sections, which must be built into unit masonry Work, including, but not limited to:

.1 Anchorage Devices.

.2 Flashings.

.2 Loose Steel Lintels.

1.4 Quality Assurance

.1 Appearance and Blend Characteristics: Provide face brick type to match existing face brick on main building as closely as reasonable in colour type, colour range and blend percentage.

.2 Single Source Responsibility for Masonry Units: Obtain masonry units from one Manufacturer.

.3 Single Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality including colour for exposed masonry, from one Manufacturer for each cementitious component and from one source and producer for each aggregate.

.4 Field Constructed Mock-Ups: Prior to installation of masonry Work, erect sample wall panels to further verify selections made for colour and texture characteristics, under sample submittals of masonry units and mortar, and to represent completed masonry Work for qualities of appearance, materials, construction and workmanship.

.5 Build mock-ups for the following types of masonry in sizes approximately 1800 mm long by 1220 mm high, by full thickness.

.1 Typical exterior face brick wall.

1.5 Submittals

.1 Product Data: Submit Manufacturer's Product Data for each type of masonry unit, accessory and other manufactured Products.

.2 Compliance: Submit certifications that each type of masonry unit complies with specified requirements.

.3 Colour Selection: For initial selection submit:

.1 Unit masonry samples showing full extent of colours and textures available for each type of exposed masonry unit required.

.2 Coloured mortar samples showing full extend of colours available.

.4 Samples: For verification purposes submit:

.1 Unit masonry samples for each type of exposed masonry unit include full range of colour and texture to be expected in completed Work.

.2 For selection of brick, submit products of all Manufacturers that the Manufacturers or their agents consider to be their closest match. Re-submit until match meets approval of Architect.

.3 Coloured masonry mortar samples for each colour required showing the full range of colour which can be expected in the finished Work. Label samples to indicate type and amount of colorant used.

1.6 Referenced Standards

.1 Comply with the applicable provisions of all codes, standards and Specifications referenced in this Section, except as modified by the requirements of theses Contract Documents, including, but not limited to the following:

ACI 531 - Building Code Requirements for Masonry Structures.

ACI 531R - Commentary on Building Code Requirements for Masonry Structures.

ACI 530.1 - Specification for Masonry Construction.

ASTM C-129 - Non-Load Bearing Masonry Units.

BIA - Technical Notes on Brick Construction

NCMA - TEK Bulletins.

1.7 Delivery, Storage And Handling

.1 Deliver masonry materials to project in undamaged condition. Store and handle materials to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion or other causes.

.2 Limit moisture absorption of concrete masonry units during delivery and until time of installation to the maximum percentage specified for Type I units for the average annual relative humidity as reported by the U.S. Weather Bureau Station nearest project Site.

.3 Store cementitious materials off the ground, under cover and in a dry location.

.4 Store and protect aggregates where grading and other required characteristics can be maintained.

.5 Store masonry accessories including metal items to prevent deterioration by corrosion and accumulation of dirt.

1.8 Project Conditions

.1 Protection of Work: During erection, cover top of walls with waterproof sheeting at end of each day's Work. Cover partially completed structures when Work is not in progress.

.1 Extend cover a minimum 600 mm down both sides and hold cover securely in place.

.2 Do not apply uniform floor or roof loading for at least twelve (12) hours after building masonry walls or columns.

.3 Staining: Prevent grout, mortar or soil from staining the face of masonry to be left exposed or painted. Remove grout or mortar in contact with such masonry immediately.

.4 Do not apply concentrated loads for at least three (3) days after building masonry walls or columns.

.5 Protect base of walls from rain-splashed much and/or mortar splatter by means of coverings spread on ground and over wall surfaces.

.6 Protect sills, ledges and projections from droppings or mortar.

.7 Cold Weather Protection:

.1 Do not lay masonry units that are wet or frozen.

.2 Remove any ice or snow formed on masonry bed by carefully applying heat until top surface is dry to the touch.

.3 Remove masonry damaged by freezing conditions.

.4 For clay masonry units with initial rates of absorption which require them to be wetted before laying, comply with the following:

.1 For units with surface temperature above 0°C, wet with water heated to above 21°C.

.2 For units with surface temperature below 0°C, wet with water heated to above 54°C.

.8 Perform the following construction procedures while masonry Work is progressing. Temperature ranges indicated below apply to air temperature existing at time of installation, except for grout:

.1 For Grout: Temperature ranges apply to anticipated minimum night temperatures. In heating mortar and grout materials, maintain mixing temperature selected within 5.5°C.

.2 5°C to 0°C.

.1 Mortar: Heat mixing water to produce mortar temperature between 5°C and 49°C.

.2 Grout: Follow normal masonry procedures.

.3 0°CF to -4°C:

.1 Mortar: Heat mixing water and sand to produce mortar temperatures between 5°C and 49°C. Maintain temperatures of mortar on boards above freezing.

.2 Grout: Heat grout materials to 32°C to produce in-place grout temperature of 21°C at end or Work day.

.4 -4°C to -7°C:

.1 Mortar: Heat mixing water and sand to produce mortar temperatures between 5°C and 49°C. Maintain temperatures of mortar on boards above freezing.

.2 Grout: Heat grout materials to 32°C to produce in-place grout temperature of 21°C at end of Work day.

.3 Heat both side of walls under construction using salamanders or other heat sources.

.4 Use windbreaks or enclosures when wind is in excess of 24 km/h.

.5 -7°C and below:

.1 Mortar: Heat mixing water and sand to produce mortar temperatures between 5°C and 49°C.

.2 Grout: Heat grout materials to 32°C to produce in-place grout temperature of 21°C at end of Work day.

.3 Masonry Units: Heat masonry units so that they are above 7°C at time of laying.

.4 Provide enclosure and auxiliary heat to maintain an air temperature of at least 5°C for twenty-four (24) hours after laying units.

.5 Do not heat mixing water for mortar and grout to above 71°C.

.9 Protect completed masonry and masonry not being worked on in the following manner: (temperature ranges indicated apply to mean daily air temperatures except for grouted masonry; if for grouted masonry, temperature ranges apply to anticipated minimum night temperatures.)

.1 5°C to 0°C.

.1 Protect masonry from rain or snow for at least twenty-four (24) hours by covering with weather-resistant membrane.

.2 0°C to -4°C.

.1 Completely cover masonry with weather-resistant membrane for at least twenty-four (24) hours.

.3 -4°C to -7°C:

.1 Completely cover masonry with weather-resistant insulating blankets or similar protection for at least twenty-four (24) hours; forty-eight (48) hours for grouted masonry.

.4 -7°C and below:

.1 Except as otherwise indicated, maintain masonry temperature above 0°C for twenty-four (24) hours using enclosures and supplementary heat, electric blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 5°C for forty-eight (48) hours.

2. PRODUCTS

2.1 Masonry Units, General

.1 Obtain masonry units from one Manufacturer, of uniform texture and colour for each kind required, for each continuous area and visually related areas.

2.2 Brick Made From Clay Or Shale

.1 General: Comply with referenced standards and other requirements indicated below applicable to each form of brick required.

.2 Size: Provide brick manufactured to the following actual dimensions:

.1 Metric Modular Face Brick, 90 x 190 x 257

.3 Provide special molded shapes where indicated and for application requiring brick of form, size and finish on exposed surfaces which cannot be produced from standard brick sizes by sawing.

.4 For sills, caps and similar applications resulting in exposure of brick surfaces which otherwise would be concealed from view, provide uncored or unfogged units with all exposed surfaces finished.

.5 Facing Brick: STM C-216, and as follows:

.1 Grade SW, .32 Texture and Colour: Match Main Building

3. EXECUTION

3.1 Workmanship

.1 Build masonry Work true-to-line, plumb, square, and level, with vertical joints in proper alignment.

.2 Tolerances for exposed masonry Work shall be:

.1 Variation from mean plane: 3 mm under 2.5 m straight edge.

.2 Variation in masonry openings: 6 mm maximum.

.3 Variation from plumb: 9 mm in 6 m.

.3 Assume complete responsibility for dimensions, plumbs, and levels of this Work and constantly check same with graduated rod.

.4 Masonry courses to be of uniform height, and both vertical and horizontal joints to be of equal and uniform thickness.

.5 Construct walls upward in a uniform manner, no one portion being raised more than 4 feet above another at any time. Build no more than 1500 mm of wall measured vertically in any one day.

.6 Buttering corners of units, throwing mortar into joints, and deep or excessive furrowing of bed joints will not be permitted. Do not shift or tap units after mortar has taken initial set. Where adjustments must be made after mortar has started to set, remove mortar and replace with fresh supply.

3.2 Mortar and Pointing

1. Make all joints uniform in thickness, straight, in line, and with mortar compressed to form concave joints.

3.3 Building In

.1 Build in door and window frames, steel lintels, sleeves, anchor bolts, anchors, nailing strips, and other items to be built into masonry.

.2 Do not distort metal frames. Bed anchors of frames in mortar and fill frame voids with mortar or grout as walls are erected.

3.4 Control Joints

.1 Provide continuous vertical control joints in veneer walls at locations indicated. Form control joints as detailed. Stop masonry reinforcing each side of joints.

3.5 Masonry Reinforcing

.2 Veneer shall be continuously reinforced and tied together in bed joints with masonry reinforcing @ 400 o/c.

.3 Place masonry reinforcing in first and second bed joints above and below openings. Reinforcing in first bed joint shall be continuous. Second bed joint reinforcing shall extend 600 mm beyond each side of opening.

.4 Place continuous reinforcing in second bed joint below the tops of walls.

.5 Lap reinforcement minimum of 150 mm at splices and cut and bend corners.

3.6 Cutting Masonry

.6 Cutting of masonry units exposed in finished Work is to be done with accepted type power saw. Where electrical conduit outlets and switch boxes occur, grind and cut units before services are installed.

.7 Obtain Contract Administrator's permission before cutting any part of area which may impair appearance or strength of the Work.

.8 Patching of masonry is not permitted without Contract Administrator's authorization.

3.7 Provisions for Other Trades

.9 Provide openings in masonry walls where required or indicated.

.10 Accurately locate chases and openings and neatly finish to required sizes.

.11 Where masonry encloses conduit, ducts, and piping, bring to proper level indicated and as directed. Do not cover any pipe or conduit chases or enclosures until advised that Work has been reviewed and tested.

.12 Build masonry neatly around conduit, ducts, sleeves, and piping passing through.

3.8 Cleaning

.13 On completion, remove any excess mortar and smears that may remain, using wood paddles or scrapers.

.14 Point or replace defective mortar to match existing as required or directed.

.15 Scrub surfaces to be cleaned using non-acid cleaning solution of type which will not harm constructed masonry. Check masonry unit Manufacturer for acceptable solution. Clean trial test area and obtain permission to proceed.

.16 Use large amounts of water and do cleaning in accordance with solution Manufacturer's instructions.

.17 Repeat cleaning operations as often as necessary until Work is satisfactory.

END OF SECTION

CONCRETE UNIT MASONRY

1. GENERAL

1.1 Work Included

.1 Concrete Block Masonry.

.2 Installation of Masonry Accessories.

.3 Parging.

1.2 Standards

.1 CAN 3-A165 Series, Canadian Standards Association (CSA) Standards on Concrete Masonry Units.

.2 Perform masonry Work to CSA S304.1, CSA A370 and CAN 3-A371 except where specified otherwise.

.3 Conform to the National Building Code of Canada (NBC).

1.3 Cold Weather Requirements

.1 Conform to weather protection requirements of Clause 5.15 in CSA A371 Masonry Construction for Buildings.

1.4 Protection

.1 Cover tops of completed and partially completed walls with waterproof coverings at end of each working day. Drape covers over walls and extend 600 mm down both sides. Anchor securely in position.

.2 Protect adjacent finished surfaces from marking or damage due to masonry Work.

.3 Provide temporary bracing of masonry Work during erection to prevent damage due to winds or other lateral loads until permanent structure provides adequate bracing.

1.5 Storage and Handling

.1 Store materials on-site in a manner to prevent damage. Store masonry units off the ground.

.2 Protect all materials from damage due to weather conditions.

.3 Handle materials carefully to prevent chipping and breaking.

2. PRODUCTS

2.1 Materials

.1 Concrete Blocks: to CSA A165.1, normal weight, type H/15/A/M, modular size.

.2 Special Shapes: Provide Type H/15/A/M Bull-Nosed units for exposed corners. Provide purpose made shapes for lintels and bond beams. Provide additional special shapes as indicated or required.

2.2 Exposed Faces

.1 Notwithstanding visual inspection requirements of CSA Standards, masonry units shall be free of surface indentations, surface cracks due to manufacture, or chipping. Units so delivered shall not be used where exposed to view, but may be used where concealed.

3. EXECUTION

3.1 Workmanship

.1 Build masonry Work true-to-line, plumb, square, and level, with vertical joints in proper alignment.

.2 Tolerances for exposed masonry Work shall be:

.1 Variation from mean plane: 3 mm under 2.5 m straight edge.

.2 Variation in masonry openings: 6 mm maximum.

.3 Variation from plumb: 9 mm in 6 m.

.3 Assume complete responsibility for dimensions, plumbs, and levels of this Work and constantly check same with graduated rod.

.4 Masonry courses to be of uniform height, and both vertical and horizontal joints to be of equal and uniform thickness.

.5 Extend non-load bearing partitions to bottom surface of floor or roof construction above. Provide lateral support anchors attached to floor or roof above to requirements of CAN3-S304. Fill topmost joint with mortar.

.6 Extend non-load bearing partitions to underside of floor or roof construction above and provide 25 mm deflection clearance. Install lateral support angles and insulation filler as detailed.

.7 Construct walls upward in a uniform manner, no one portion being raised more than 4 ft above another at any time. Build no more than 1,500 mm of wall measured vertically in any one day.

.8 Buttering corners of units, throwing mortar into joints, and deep or excessive furrowing of bed joints will not be permitted. Do not shift or tap units after mortar has taken initial set. Where adjustments must be made after mortar has started to set, remove mortar and replace with fresh supply.

3.2 Blockwork

.1 Lay concrete block in running bond, with thicker end of face shell upward. Coursing to be modular 200 mm for one block and one joint.

.2 Use special shaped units where indicated, specified, or required. Use bull-nosed units for exposed external corners, door and window jambs, etc. Exposed open cells not permitted.

.3 Concrete masonry units shall have face shells and their end joints fully filled with mortar, and joints squeezed tight. Also fill webs at cores, to be reinforced and grouted, and strike flush at core taking care to prevent mortar from falling into core.

.4 Tie intersecting non-bearing walls together with masonry reinforcing every second course.

.5 Do not tie intersecting bearing walls together in masonry bond, except at corners.

3.3 Mortar and Pointing

.1 Make all joints uniform in thickness, straight, in line, and with mortar compressed to form concave joints.

3.4 Building In

.1 Build in door and window frames, steel lintels, sleeves, anchor bolts, anchors, nailing strips, and other items to be built into masonry.

.2 Do not distort metal frames. Bed anchors of frames in mortar and fill frame voids with mortar or grout as walls are erected.

3.5 Bearings

.1 Fill concrete block solid with 20 MPa concrete for two (2) courses below bearing points of structural members and where indicated on Drawings.

.2 Install building paper and wire mesh reinforcing in the bed below the second block course from top.

3.6 Control Joints

.1 Provide continuous vertical control joints in concrete block partitions and walls at locations indicated, or at a maximum 7.6 m o.c.

.2 Form control joints as detailed. Stop masonry reinforcing each side of joints.

3.7 Expansion Joints

.1 Construct expansion joints where indicated, as detailed.

3.8 Masonry Reinforcing

.1 Concrete block walls and partitions shall be continuously reinforced and tied together with masonry reinforcing in every second block bed joint.

.2 Place masonry reinforcing in first and second bed joints above and below openings. Reinforcing in first bed joint shall be continuous. Second bed joint reinforcing shall extend 600 mm beyond each side of opening.

.3 Place continuous reinforcing in second bed joint below the tops of walls.

.4 Lap reinforcement minimum of 150 mm at splices and cut and bend corners.

.5 Vertical reinforcing bars to be continuous into lintels, through intermediate bond beams, and hooked into top of wall bond beams.

3.9 Cutting Masonry

.1 Cutting of masonry units exposed in finished Work is to be done with accepted type power saw. Where electrical conduit outlets and switch boxes occur, grind and cut units before services are installed.

.2 Obtain Contract Administrator's permission before cutting any part of area which may impair appearance or strength of the Work.

.3 Patching of masonry is not permitted without Contract Administrator's authorization.

3.10 Bond Beams

.1 Install concrete block bond beams where indicated and where required for bearing of structural members.

.2 Make bond beams of special blocks with two (2) deformed 15M reinforcing bars placed in bottom, and fill with 20 MPa concrete.

3.11 Reinforced Block Lintels

.1 Install reinforced concrete block lintels at openings where steel lintels are not indicated.

.2 Cast and cure lintels on plank. Set special channel lintel blocks using specified mortar. Place wood stops at either end of lintel to prevent movement.

.3 Place 25 mm of concrete in voids, place in deformed reinforcing bars and place concrete to level of block sides. Rod and tamp concrete well without disturbing reinforcing. Allow lintels to cure seven (7) days before removing shores.

.4 Minimum bearing shall be 400 mm each side of openings.

3.12 Nailing Inserts

.1 Install nailing inserts as required for wall strapping set in mortar joints at 400 mm centres each way, to Manufacturer's instructions.

3.13 Parging

.1 Apply parging in a uniform coat, minimum 10 mm thick. Use sufficient pressure to ensure bonding.

3.14 Provisions for Other Trades

.1 Provide openings in masonry walls where required or indicated.

.2 Accurately locate chases and openings and neatly finish to required sizes.

.3 Where masonry encloses conduit, ducts, and piping, bring to proper level indicated and as directed. Do not cover any pipe or conduit chases or enclosures until advised that Work has been reviewed and tested.

.4 Build masonry neatly around conduit, ducts, sleeves, and piping passing through.

3.15 Cleaning

.1 On completion, remove any excess mortar and smears that may remain, using wood paddles or scrapers.

.2 Point or replace defective mortar to match existing as required or directed.

.3 Scrub surfaces to be cleaned using non-acid cleaning solution of type which will not harm constructed masonry. Check masonry unit Manufacturer for acceptable solution. Clean trial test area and obtain permission to proceed.

.4 Use large amounts of water and do cleaning in accordance with solution Manufacturer's instructions.

.5 Repeat cleaning operations as often as necessary until Work is satisfactory.

END OF SECTION

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DIVISION 05

Reviewed and Approved

Date

STEEL JOISTS

1. GENERAL

1.1 Work Included

.1 Joist design.

.2 Standard type steel joists and bridging.

.3 Bearing plates and angles with anchors.

.4 Joist stools and anchor bolts for joists.

.5 Plate clips for additional roof framing.

.6 Welding to steel supports.

.7 Shop prime paint steel joists and appurtenances.

.8 Field touch up of primed surfaces.

1.2 Design Standards, Code Requirements

.1 Conform to requirements of Canadian Standards Association (CAN/CSA)-S16.1, CSA S136, the Canadian Institute of Steel Construction (CISC) "Code of Standard Practice for Buildings" and "Steel Joist Facts".

.2 Conform to the Provincial Construction Safety Act.

.3 Use loads, load combinations and stress levels shown on drawings and in accordance with the latest edition of the National Building Code of Canada (NBC).

.4 Design joists to withstand their own weight and design loads indicated on Drawings, with not more than allowable deflection of L/240 for all intermediate joists and L/400 for joists adjacent and parallel to continuous support walls based on live load.

.5 Joists and connections are to be designed by a registered Professional Structural Engineer, registered in the Province of Manitoba.

.6 Perform all welding in accordance with requirements of CSA W59.

1.3 Qualifications

.1 All Work is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 Division 2.1.

1.4 Inspection and Testing

.1 Shop and field inspection and testing is to be performed by an Inspection and Testing Firm appointed and paid by the City.

.2 Provide free access to all portions of Work in the shop and in the field and cooperate with appointed firm.

.3 Pay all additional costs for inspection and re-inspection due to defective workmanship or materials.

.4 If requested by the Contract Administrator, submit four (4) copies of mill test reports, properly correlated to materials actually used.

1.5 Shop Drawings, Submittals

.1 Provide a fabrication and erection schedule to the Contract Administrator prior to commencement of shop fabrication and field erection, in ample time to allow proper scheduling of inspection and testing.

.2 Shop Drawings and design briefs are to bear the seal of a Professional Structural Engineer, registered in the Province of Manitoba.

.3 Submit Shop Drawings and design briefs in accordance with Section 01300.

.4 Clearly indicate profiles of rolled sections, sizes, spacing and location of joists, connections, bridging, reinforcing, anchorage, cambers, loads, and accessories.

.5 Include erection drawings, elevations, and details.

.6 Indicate welded connections using welding symbols in compliance with CISC Welding Standards. Clearly indicate net weld lengths.

.7 Shop Drawing review by the Contract Administrator is solely to ascertain conformance to the general design concept.

.8 Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.

.9 Review 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.

.10 Responsibility for verification and correlation of field dimensions, fabrication processes, techniques of construction, installation, and coordination of all parts of the Work rests with the Contractor.

2. PRODUCTS

2.1 Materials

.1 All materials are to be new.

.2 Steel: structural type conforming to CAN/CSA-G40.21, Type W 380 MPa for chord sections and 260 MPa minimum for web material, shop primed.

.3 Anchor Bolts: fabricated from material conforming to CAN/CSA G40.21, type W, yield strength 300 MPa; nuts and washers to be of equal or greater strength than bolts.

.4 Welding Materials: conforming to CSA W59.

.5 Primer: CISC/CPMA 2-75 for joists to be finish painted.

2.2 Fabrication

.1 Fabricate steel joists in accordance with CAN/CSA S16.1.

.2 Verify all Drawing dimensions prior to commencing fabrication.

.3 Fabricate joists of straight members arranged to form a triangulated truss type structure without joint eccentricities.

.4 No splices are allowed in chord members.

.5 Fabricate bottom joist chord extensions where indicated.

.6 Fabricate joist webs to permit passage of mechanical ducts as detailed. Reinforce joists in accordance with design conditions.

.7 Fabricate and weld plate clips to steel joist as indicated on the Drawings for additional channel roof framing. Coordinate with metal fabrication supplier for requirements.

.8 Camber joists for dead load deflection.

2.3 Shop Painting

.1 Clean all members, remove loose mill scale, rust, oil, dirt, and other foreign matter. Prepare surface according to SSPC SP 7.

.2 Apply one (1) coat of prime paint in the shop to all steel surfaces, except:

.1 Surfaces to be encased in concrete.

.2 Surfaces to receive field installed stud shear connectors.

.3 Surfaces and edges to be field welded.

.3 Apply paint under cover on dry surfaces only and when surface and air temperatures are above 5°C.

.4 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.

.5 Patch paint bolts, nuts, sharp edges, and corners one coat before full prime coat is applied.

.6 Apply paint by brush or spray to a dry film thickness of 0.05 mm minimum.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of this Work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace members damaged during transit or erection, before securing in position.

3.3 Erection

.1 Erect steel joists in accordance with CAN/CSA-S16.1 and Drawings.

.2 Provide minimum 100 mm bearing for joists supported on concrete and masonry. Provide minimum 65 mm bearing for joists supported on steel supports.

.3 Extend bearing chords on supports to reduce eccentricity.

.4 During erection provide all temporary bracing required for induced loads and stresses.

.5 Coordinate placement of anchor bolts and bearing plates in masonry construction.

.6 Field weld joists to bearing plates and steel supports after alignment and positioning.

.7 Provide bridging and bracing.

.8 Do not weld at temperature below 5ºC except with written permission of the Contract Administrator.

.9 Do not field weld wet surfaces or during rain unless under cover.

.10 Conform to CSA W59 for minimum preheat and interpass temperatures.

.11 Do not permit erection of decking until joists are sufficiently braced and bridging is installed.

.12 Obtain Contract Administrator's written permission prior to field cutting or altering joists or bridging.

.13 After erection, field prime anchorages, bearing plates, field welds and other appurtenances and abrasions and damage to shop primer.

END OF SECTION

METAL DECK

1. GENERAL

1.1 Work Included

.1 Metal roof deck complete with cover plates, closures, flashing, fastenings, and installation.

.2 Angles complete with required anchorage.

.3 Angle framing around openings up to 450 mm maximum in any dimension.

.4 Cut openings through deck.

1.2 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate decking plan, deck profile dimensions and thicknesses, anchorage, supports, projections, openings and reinforcement, closures, flashings, applicable accessories, and details.

.3 Shop Drawings and design briefs are to bear the seal of a Professional Structural Engineer registered in the Province of Manitoba.

1.3 Design

.1 Design deck to safely support live and dead loads shown on Drawings and in accordance with Canadian Standards Association (CSA) S136. Ensure ponding affects are included.

.2 Maximum working stress under full live and dead loads shall not exceed 140 MPa.

.3 Live load deflection shall not exceed 1/240 of span.

.4 Roof deck to provide building stability through diaphragm action.

2. PRODUCTS

2.1 Materials

.1 Metal: galvanized sheet steel conforming to American Society for Testing and Materials (ASTM) A446, Grades A or B as shown in Manufacturers' current literature.

.2 Primer: zinc dust/zinc oxide alkyd type, conforming to CAN/CGSB-1.181, compatible with finish painting (see Section 09900).

2.2 Deck and Related Accessories

.1 Roof Deck: minimum 0.76 mm thickness base sheet steel, galvaneal, three equal spans, 38 mm deep profile.

.2 Closure Strips, Flashing, Cover Plates: minimum 0.76 mm thickness base sheet steel, galvaneal coating, of required profiles and sizes.

2.3 Fabrication

.1 Fabricate metal deck in accordance with requirements of CSA S136, Canadian Sheet Steel Building Institute (CSSBI) Standards and Drawings.

.2 Fabricate deck with interlocking side laps.

.3 Fabricate to generally span over three (3) or more supports unless shown otherwise on the Drawings.

3. EXECUTION

3.1 Examination

.1 Before starting erection, take field measurements and examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of this Work implies acceptance of existing conditions.

3.2 Damaged Members

.1 Repair or replace sections damaged during transit or erection, before securing in position.

3.3 Installation

.1 Erect metal deck in accordance with requirements of CSSBI and the Drawings. Align and level deck on structural supports.

.2 Locate all end joints over supports.

.3 Lap all end joints on non-cellular deck 50 mm minimum.

.4 Maintain minimum end bearing on steel supports of 38 mm for deck up to 45 mm deep.

.5 Maintain minimum end bearing on masonry supports of 100 mm for deck up to 45 mm deep.

.6 Lay out lines of supporting steel on top surface of deck to produce accurate welds and prevent burns through deck from improper weld location.

.7 Welding shall be done by qualified welders who shall make practice welds. Prior to actual job welding, practice welds shall be made on the deck to be used to check adequacy of the welding rod amperage and burn off rate to produce satisfactory fusion for the various welds required. Both the practice welds and actual job welds shall be inspected by the steel deck erector as to size and spacing and tested by pry tests to assure metal to metal fusion.

.8 Fasten to all supports with 20 mm diameter fusion welds at 300 mm o.c. maximum.

.9 Mechanically fasten sidelaps at 600 mm o.c. by button punch.

.10 Install angle or channel closures full length on all deck edges at perimeter, walls, and openings.

.11 Install acoustical closures over all walls and partitions.

.12 Cut all holes required in deck for drains, vents, mechanical equipment, ducts, and conduits.

.13 Reinforce openings up to 450 mm in any dimension with 55 x 55 x 6 mm steel angles. Place reinforcing angles at right angles to ribs, extend out two ribs each side and weld.

.14 Install deck to provide flat upper surface, with all flange surfaces touching a 1,200 mm straight edge over structural supports.

.15 If two (2) or more adjacent flanges on any deck section are concave or convex so that only edges or crowns touch straight edge, repair or replace deck sections.

.16 Immediately after installation, touch up welds, burned areas, and damaged areas of zinc coating with primer paint.

END OF SECTION

METAL FABRICATIONS

1. GENERAL

1.1 Work Included

.1 Shop fabricated ferrous metal items, galvanized and prime painted. The following is a list of principal items only. Refer to Drawing details for items not specifically listed.

.1 Roof framing – perimeter angles and channels as indicated.

.2 Interior masonry wall lateral support angles.

.3 Exterior masonry supports (galvanized).

.4 Loose lintels (galvanized).

.5 Mechanical supports.

.6 Boot scrapers (galvanized).

.7 Anchors, plates, bolts, nuts, screws, brackets, etc. required for Work of this Section.

.8 Bearing plates and angles for metal deck.

.9 Safety D-Anchors.

1.2 Design Code, Quality Assurance

.1 Design and fabricate stairs, landings, handrails, and balustrades to conform to requirements of the National Building Code of Canada (NBC), 1995.

.2 Perform welding in accordance with requirements of Canadian Standards Association (CSA) W59.

.3 Welding Work on all load carrying structures and assemblies is to be performed by a firm certified by the Canadian Welding Bureau to the requirements of CSA W47.1 in Division 2.1.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate profiles, sizes, connections, attachments, reinforcing, anchorage, size and type of fasteners and accessories.

.3 Include erection drawings, elevations and details where applicable.

.4 Indicate welded connections using CISC standard welding symbols. Clearly indicate net weld lengths.

.5 Shop Drawings and design briefs are to bear the seal of a Professional Engineer registered in the Province of Manitoba.

2. PRODUCTS

2.1 Materials

.1 Steel: conforming to CAN/CSA-G40.21; Type W with minimum yield strength of 300 MPa.

.2 Welding Materials: conforming to CSA W59.

.3 Bolts, Nuts, and Washers: conforming to ASTM A325.

.4 Safety D-Anchors: HWA 3732C by MSA conforming to ANSI Z-359.1 and CSA Z-259.1 complete with A325 bolts.

.5 Accessories: wall brackets, with plaster rings, flanges, escutcheons, pre-formed bends, tee fittings, flush end caps, plugs, flush splice connectors; of same material and finish to match railings and hand railings.

2.2 Finishes

.1 Primer: CISC/CPMA 2-75.

.2 Galvanizing: conforming to CAN/CSA-G164. Primer to CGSB 1-GP-178. Galvalume for touch-up.

2.3 General Fabrication

.1 Verify all dimensions on-site prior to shop fabrication.

.2 Fabricate items of sizes and profiles detailed on Drawings, with joints neatly fitted and properly secured.

.3 Fit and shop assemble in largest practical sections, for delivery to Site.

.4 Supply all components required for proper anchorage of miscellaneous metals. Fabricate anchorage and related components of same material and finish as metal fabrications, unless otherwise specified or shown.

.5 Weld connections where possible, otherwise bolt connections. Counter-sink all exposed fastenings. Cut off bolts flush with nuts.

.6 Accurately form all connections and joints with exposed faces flush, mitres and joints tight.

.7 Grind or file exposed welds and metal sections smooth and flush.

.8 Provide for flush welded or hairline butt field joints.

.9 Shop fabricate openings in members for other building components. Reinforce openings to restore member to original design strengths.

.10 Provide lugs, clips, brackets, hangers and struts as required for attaching miscellaneous metal items securely to building structure.

.11 Thoroughly clean all surfaces of rust, scale, grease and foreign matter prior to prime painting or galvanizing.

.12 Galvanize and prime paint items as shown. Do not shop prime surfaces in contact with or embedded in concrete or requiring field welding. Shop prime two (2) coats.

3. EXECUTION

3.1 Examination

.1 Before starting erection, examine other Work which may affect this Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of this Work.

.3 Commencement of erection Work implies acceptance of existing conditions.

3.2 Erection

.1 Obtain Contract Administrator's permission prior to Site cutting or making adjustments which are not part of scheduled Work.

.2 Install items plumb, square and level, fit accurately, and maintain free from distortion or defects detrimental to appearance and performance.

.3 Make provision for erection stresses and temporary bracing. Keep Work in alignment at all times.

.4 Replace items damaged in course of installation.

.5 Perform required field welding. Grind all visible field welds smooth.

.6 Perform necessary cutting and altering for the installation of Work of other sections, and as indicated on Drawings. No additional cutting is to be done without the permission of the Contract Administrator.

.7 Perform all field assembly bolting and welding to match standard of shop bolting and welding. Bolts and screws are to be concealed whenever possible.

.8 After installation, touch up field bolts, nuts, welds, and scratched and damaged prime painted surfaces. Field touch-up primer to be same as shop primer. Touch up galvanized surfaces with galvalume.

.9 Supply, to appropriate Sections, items required to be cast into concrete and built into masonry, complete with necessary setting templates.

END OF SECTION

ALUMINUM FABRICATIONS

1. GENERAL

1.1 Work Included

.1 Access hatches, frames, and covers.

.2 Ladders.

.3 Stairs and grating.

.4 Checker plate covers and framing.

.5 Stainless steel bolts for bolted connections.

.6 Stainless steel anchor bolts and anchorages for all aluminum equipment supplied.

1.2 Standards

.1 Do aluminum Work to Canadian Standards Association (CSA CAN) 3-S157.

.2 Welding to CSA W59.2

.3 Company certification to W47.2.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Clearly indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

.3 Include erection Drawings, elevations and details where applicable.

.4 Indicated welded connections using Canadian Institute of Steel Construction (CISC) standard welding symbols. Clearly indicate net weld lengths.

2. PRODUCTS

2.1 Materials

.1 Aluminum to CSA Standard HA, 6351-T6 Alloy unless specified otherwise.

.2 Nuts, bolts, and fastening devices connecting aluminum parts to aluminum, concrete, or other materials: Stainless steel, with appropriate isolation devices.

.3 Bituminous Paint: To CGSB 1-GP-108M.

.4 Aluminum Grating: acceptable Product Fisher & Ludlow Fisholoid Aluminum Grating, Type 30-102M.

2.2 General Fabrication

.1 Verify all dimensions on-site prior to fabrication.

.2 Connect bearing bars in a panel with a bar of same depth as bearing bars and minimum thickness of 5 mm.

.3 Finish openings requiring the cutting of four (4) or more bearing bars in the same manner as the end of the panel.

.4 Match position of bars and tie rods in adjacent panels to preserve a continuous appearance.

3. EXECUTION

3.1 Examination

.1 Before starting erection, examine Work done under other Sections which may affect the Work.

.2 Notify the Contract Administrator of any conditions which would prejudice proper installation of the Work.

.3 Commencement of erection Work implies acceptance of existing conditions.

3.2 Erection

.1 Obtain the Contract Administrator's permission prior to Site cutting or making adjustments which are not part of the scheduled Work.

.2 Install items plumb, square and level; fit accurately, and maintain free from distortion or defects detrimental to appearance and performance.

.3 Make provisions for erection stresses and temporary bracing. Keep Work in alignment at all times.

.4 Replace items damaged in course of installation.

.5 Perform required field welding. Visible field welds to be smooth, grind as required.

.6 Perform necessary cutting and altering for the installation of Work of other Sections, and as indicated the Drawing. No additional cutting is to be done without the acceptance of the Contract Administrator.

.7 Perform all field assembly bolting and welding to match standard of shop bolting and welding. Bolts and screws are to be concealed whenever possible.

.8 Clip adjacent grating panels edges together at 1,500 mm spacing to prevent differential vertical movement.

.9 Provide two (2) hold-down clips at each end of the panels if not detailed on the Drawings.

.10 Provide anchors for setting in concrete with minimum 100 embedment.

.11 Paint aluminum surfaces in contact with concrete with two (2) coats of alkali-resistant bituminous paint.

.12 Prevent electrolysis between aluminum and dissimilar metals in contact with appropriate isolation devices.

END OF SECTION

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DIVISION 06

Reviewed and Approved

Date

ROUGH CARPENTRY

1. General

1.1 Work Included

.1 Roof curbs and parapets.

.2 Dividing wall in the existing Effluent Gate Chamber (EGC).

.3 Blocking in wall and roof openings.

.4 Wood furring and grounds.

.5 Concealed wood blocking for support of items and equipment supported by walls.

.6 Wood treatment.

1.2 Related Sections

.1 Cast-in-place Concrete: Concrete openings to receive wood blocking: Section 03300

.2 Concrete Unit Masonry: Masonry openings to receive wood blocking: Section 04220

.3 Modified Bituminous Roofing: Section 07525

1.3 References

.1 Canadian Standards Association (CSA) O80M - Wood Preservation.

.2 National Lumber Grades Authority (NLGA) - Standard Grading Rules for Canadian Lumber.

.3 CSA O121M - Douglas Fir Plywood.

.4 CSA O141 - Softwood Lumber.

.5 CSA O151M - Canadian Softwood Plywood.

1.4 Quality Assurance

.1 Lumber Grading Agency: NLGA.

.2 Wood Treatment: CSA O80M.

1.5 Delivery, Storage, and Handling

.1 Protect Products of this Section under waterproof coverings.

2. PRODUCTS

2.1 Materials

.1 Softwood lumber: CSA O141, Non-structural light grading 19% maximum moisture content.

.2 Plywood: CSA O121M - Douglas Fir CSA O151M - Softwood type, with waterproof glue.

.3 Fasteners: Electro Hot dipped galvanized steel for exterior, high humidity, and treated wood locations; plain finish elsewhere; size and type to suit condition.

.4 Anchors: Toggle bolt type for anchorage to hollow masonry Expansion shield and lag belt type for anchorage to solid masonry or concrete Bolts or ballistic fasteners for anchorages to steel.

2.2 Wood Treatment

.1 Wood Preservative Pressure Treatment: CSA O80M using waterborne preservative with 0.30% retainage, manufactured by Wolman.

3. EXECUTION

3.1 Site Applied Wood Treatment

.1 Apply preservative treatment in accordance with CSA O80M Manufacturer's instructions.

.2 Treat site-sawn ends.

.3 Allow preservative to cure prior to erecting members.

3.2 Installation

.1 Erect wood framing members level and plumb.

.2 Space framing and furring as noted on Drawings.

.3 Construct curb members of single pieces.

.4 Curb all roof openings except where prefabricated curbs are provided. Form corners by lapping side members alternately.

.5 Provide blocking, sized to suit, for support of surface mounted accessories and equipment.

.6 Provide wood blocking around each door frame opening.

.7 Place miscellaneous blocking, furring, strapping, canting, nailing strips, framing and sheathing where indicated on Drawings and as required for secure support of anchorage of other specified materials. Place members true to lines and levels. Secure rigidly in place.

.8 Coordinate the installation of bucks, anchors, blocking, which is to be placed in or behind partitions. Allow such items to be installed after partition framing is complete. Ensure that allowance is made for thickness of wall finish to be applied.

.9 Place sheathing with end joints staggered. Secure sheets over firm bearing. Maintain minimum 1.5 mm and maximum 3 mm spacing between joints on walls. Place perpendicular to framing members.

END OF SECTION

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DIVISION 07

Reviewed and Approved

Date

BITUMINOUS DAMPPROOFING

1. GENERAL

1.1 Work Included

.1 Clean and prepare surfaces to receive dampproofing.

.2 Apply dampproofing to all exterior surfaces of exterior walls from 50 mm below finished grade levels or as shown on the Drawings down to and over tops and sides of footings.

.3 Caulk junction of walls and footings and around pipes and services entering through walls.

1.2 Related Work

.1 Backfilling for Structures: Section 02220

.2 Concrete Accessories: Section 03250

.3 Cast-In-Place Concrete: Section 03300

.4 Rigid Wall Insulation, Moisture Barrier, Sheet Air/Vapour Barriers: Section 07212

1.3 Examination

.1 Examine surfaces to be damp-proofed and have all defects remedied prior to application of dampproofing.

.2 Tie holes, honeycombs, and other imperfections - are to be made good under Concrete Section 03300.

1.4 Storage and Handling

.1 Provide and maintain dry, off-ground weatherproof storage.

.2 Store materials on supports to prevent deformation.

.3 Remove only in quantities required for same day use.

.4 Store materials in accordance with Manufacturers written instructions.

1.5 Environmental Requirements

.1 Do not proceed with Work when wind chill effect would tend to set bitumen before proper curing takes place.

.2 Maintain air temperature and substrate temperature at dampproofing installation area above 5°C for twenty-four (24) hours before, during and twenty-four (24) hours after installation, or as recommended by Manufacturer.

.3 Do not apply dampproofing in wet weather.

2. PRODUCTS

2.1 Materials

.1 Asphalt: to CAN/CGSB-37-GP-16Ma. Acceptable Products: Bakelite/Flintguard 710-11 Foundation Coating and Elsro 505 Fibrated Foundation Coating.

.2 Asphalt primer: to CAN/CGSB 37-GP-9Ma. Acceptable Products: Bakelite/ Flintguard 910-01 Asphalt Primer and Elsro 510 Asphalt Primer.

.3 Sealing compound: plastic cutback asphalt cement to CAN/CGSB-37.5. Acceptable Products: Bakelite/Flintguard 770-05, Elsro recommended sealing compound.

3. EXECUTION

3.1 Application

.1 Apply dampproofing Products in one (1) coat in accordance with the Manufacturer's written instructions.

.2 Thoroughly clean concrete surfaces with wire brushes to remove dirt and loose scale before applying dampproofing.

.3 Seal exterior joints between foundation walls and footings, and around penetrations through dampproofing with sealing compound.

.4 Apply primer.

.5 Apply dampproofing evenly by brush or spray in one application, completely covering surfaces with no bare spots. Application shall be inspected by the Contract Administrator before backfilling commences.

.6 Apply dampproofing at the rate of one (1) litre/m^2.

.7 Apply two (2) additional coats of dampproofing to vertical corners and construction joints for a minimum width of 230 mm on each side, and 230 mm minimum width around pipes passing through walls.

END OF SECTION

AIR VAPOUR BARRIER QUALITY CONTROL

1. GENERAL

1.1 Purpose

.1 The purpose of this Specification is to ensure control of the quality of air/vapour barrier membrane installations on new or existing buildings.

1.2 Work Included

.1 This Specification applies to most Site applied air/vapour barrier materials and systems for the building, including air barrier membranes adhered to wall surfaces of concrete, masonry, plywood or gypsum board, and to connections and transitions between these and windows, doors, floor slabs, lintels, roofing and waterproofing membranes. It includes, but is not limited to, modified bitumen, rubber and plastic compounds, sheet metal air/vapour barrier systems and the junctions, interconnections and tie-ins between these membranes and all other types of air/vapour barrier membranes and building components.

1.3 Work Not Included

.1 Except for junctions, interconnections and tie-ins noted above, this Specification does not apply to:

.1 Air tight drywall air/vapour barrier systems.

.2 Sprayed-in-place foam insulation systems. These are addressed in Canadian Government Specification Board (CAN/CGSB) 51.39-92.

.3 Polyethylene sheet air/vapour barrier materials. These are addressed in CAN/CGSB 51.34 M86.

.4 Pre-engineered and prefabricated air/vapour barrier systems such as curtain wall systems.

1.4 References

.1 The following publications are applicable to this Specification:

.1 Canadian Construction Materials Centre (CCMC).

.2 Technical Guide for Air Barrier Systems for Exterior Walls of Low-Rise Buildings Canadian Standards Association.

.3 Guideline on Durability in Building Canadian Standards Association (CSA) S478-95.

.4 Industrial Health and Safety Regulations, Workers Compensation Board (WCB) of Manitoba.

.5 Workplace Hazardous Materials Information System (WHMIS).

2. PRODUCTS

2.1 Standard of Acceptance

.1 Air/vapour barrier materials which have been evaluated using Technical Guide for Air Barrier Systems for Exterior Walls of Low-Rise Buildings, Masterformat Section 07195, produced by CCMC and meet or exceed the properties as defined in Section 5.0 Technical Requirements, are acceptable for use. The Manufacturer is required to submit a copy of the CCMC evaluation report to the National Air Barrier Association (NABA) office.

.2 In cases where a CCMC evaluation report is not yet available, the Manufacturers may submit documentation to the NABA office for approval. The documentation must include information on the Product history, the Manufacturer's history, and results from third party Product testing.

.3 Selected air/vapour barrier materials are considered acceptable for application on this project. Contact the NABA office for the latest list of approved Manufacturers.

2.2 Manufacturers Applications Guidelines

.1 The Manufacturers of air barrier membrane materials shall provide installation instructions for their materials. Copies of these instructions shall be provided to the Contract Administrator and to the Certified Applicator(s). Copies shall be kept on-site during air barrier installation for reference. The most current copy of these guidelines is to be filed with the NABA office by the Manufacturers.

2.3 Membrane Materials

.1 Membrane materials shall be approved by the Manufacturer for use on the substrate to which it is being applied and for both the conditions during installation and for the long-term operating conditions of the building.

.2 The Manufacturer shall supply the licensed Contractor and NABA with current laboratory test results for materials provided to the project. Test results shall be from an independent testing agency using approved test methods to establish expected performances of the air barrier membrane.

2.4 Accessory Products and Materials Compatibility

.1 Accessory Products including caulks and sealants, primers, etc. which are in direct contact with, or form part of the air barrier systems must be chemically and physically compatible with the materials to which they are applied and must be approved for that use by their Manufacturer and the Manufacturers of the air barrier materials they contact.

2.5 Delivery and Storage of Materials

.1 Materials shall be delivered to the jobsite in Manufacturer's standard commercial containers unopened, undamaged, and bearing the name of the Manufacturer, name of the contents/Product code, net weight of contents, lot or batch number, storage temperature limits, shelf life expiration date, and safety information and instructions. Store and protect materials from direct sunlight, extreme temperatures, moisture conditions, chemicals, solvents, etc., as per Manufacturer's recommendations.

2.6 Durability

.1 Product Manufacturers must certify in writing that their Products will meet all the characteristics required by the Guidelines on Durability in Buildings Canadian Standards Association (CSA) S478-95.

3. EXECUTION

.1 Coordinate Work of this Section with all other applicable Sections to ensure continuity of the air seal.

.2 Except as explicitly permitted by the materials Manufacturer, no installation Work shall be performed on surfaces exposed to inclement weather.

.3 Clean and prepare all substrates in accordance with membrane Manufacturer's application guidelines. Obtain the Certified Applicator’s approval prior to application of membrane or primer, and also before installation of insulation.

.4 Detail Work must be carefully carried out to ensure the air barrier membrane creates a continuous seal at all construction elements such as foundations, roofs and walls, and at junctures of different materials or construction types (curtain wall construction, etc.). Where installation cannot be carried out using the primary membrane compatible and materials, select other materials which suit the application.

.5 Protect finished Work. Close up air barrier membranes as soon as possible after application to protect the membranes from weather, sunlight, and damage by other

trades. Insulate over the air barrier membrane immediately after installation, if expected range of environmental concerns on either side of the membrane could result in dew point temperatures occurring within the wall, or if the membrane is on the cold side of a building shell which is being heated from the inside.

.6 Apply transition membrane to prepared surfaces as indicated on Drawings and as required by Site conditions. Follow Manufacturer's recommendations when installing air barrier membranes across unsupported openings (e.g., around windows, below edge beams, etc.).

.7 The installer shall ensure that the air/vapour barrier material is structurally supported in all areas, including transition areas, according to the requirements of the National Building Code. The material must transfer all applicable loads to the appropriate structure support which can carry all the required loads.

.8 The installer shall comply with all safety precautions, Manufacturers' instructions, WHMIS, and WCB requirements for materials handling, storage, application and disposal, and regarding labelling and provision of material safety data sheets.

.9 Prior to commencement of Work, the installer shall report in writing to the Contract Administrator any defects in surfaces or conditions which may adversely affect the performance of Products installed under this Section.

4. QUALIFICATIONS OF AIR BARRIER CONTRACTORS AND INSTALLERS

.1 The air barrier Contractor shall be formally recognized as a licensed Contractor by the National Air Barrier Association (NABA). The Contractor shall carry liability insurance and bonding.

.2 Each worker who is installing air barriers must be either a Certified Applicator or an apprentice who is registered with NABA.

.3 Each Certified Applicator can supervise a maximum of two (2) apprentices. The Certified Applicator shall have journeyman qualifications, defined as either (1) holding a certificate of qualifications or proficiency as an air barrier installer from a recognized authority, or (2) having acquired the skill of the trade by having worked as an air barrier installer for a period of not less than six years. This experience must be documented through project records which have been submitted to NABA for approval

.4 The Certified Applicator shall be thoroughly trained and experienced in the installation of air barriers of the types being applied. Certified Applicators shall perform or directly supervise all air vapour barrier Work on the project.

.5 One (1) person shall be assigned as Designated Applicator for this project. The Designated Applicator shall be a Certified Applicator in good standing with NABA. The Designated Applicator shall assume overall responsibility for installing, testing, and approving all air barrier membranes on the project.

.6 Each air barrier crew shall have available and utilize all adequate and necessary equipment, including safety equipment tools, testing and inspection devices, to execute its Work in accordance with good construction practices.

.7 A pre-job conference between the Contractor, licensed air barrier Contractor, Designated Applicator, the independent air barrier inspector or consultant, Manufacturers Representative, and any other trades affected by installation of the air barrier membrane must be held prior to the start of any installation of the air barrier membrane system. At this conference, installation and performance requirements, testing and inspection schedules, and documentation requirements will be reviewed.

5. QUALITY ASSURANCE

5.1 Work performed must be licensed under NABA Quality Assurance Program. Proof of license and certification is to be submitted to the Contract Administrator.

5.2 Air/vapour barrier installers must be trained and certified by NABA/NECA (National Energy Conservation Association).

5.3 Testing

.1 The Designated Applicator and the Certified Installers/Apprentices shall routinely inspect and test their Work as they proceed. The results of their testing and inspection efforts shall be recorded in worksheets by the Certified Applicator on the crew and confirmed by the Designated Applicator. These worksheets shall be kept on-site and be available for routine inspection by the City or the air barrier inspector. A copy of the worksheet shall be submitted to NABA on a monthly basis. The cost of these requirements is to be born by the Contractor.

.2 Designated Applicator shall inspect/test all membranes and make all necessary repairs immediately prior to their being permanently covered up. He shall document repairs made and approvals given.

.3 The Designated Applicator shall cooperate with the air barrier inspector/consultant by making construction Drawings and records available to him, including the air barrier worksheets, and providing him with other information as requested. The Designated Applicator shall assist the air barrier inspector/consultant in the performance of his duties by providing him access to scaffolding, swing stages, etc.

5.4 Documentation

.1 The Designated Applicator shall be responsible for documentation and reporting requirements for all the air barrier membranes installed on the project.

.2 Jobsite records kept by the Designated Applicator shall include dates on which membrane was installed, wall areas covered on those dates, name of the Certified Applicator(s) and apprentices, the types and lot numbers of materials used, environmental and substrate conditions including at a minimum temperatures, humidity and cleanliness during installation, variations from Drawings or Specifications, and results of any testing or inspections done by the installation crew. The Designated Applicator's worksheets must identify all areas of substrate for which he has approved application of air barrier membrane. A copy of these worksheets shall be submitted to NABA on a monthly basis.

.3 Both the licensed Contractor and the Designated Applicator are jointly responsible to submit a copy of the worksheets to the NABA office.

5.5 Verification

.1 NABA will conduct random Site verification visits to determine whether the Licensed Contractor and the Certified Installers are conforming to the NABA Specifications and the NABA Quality Assurance Program.

5.6 Inspection

.1 An important part of the Quality Assurance Program is inspections done by an independent air barrier inspector/consultant and which is paid for by the City unless specified otherwise. The inspector/consultant should review the air barrier installation worksheets, and from it do random checks, inspections and tests on the air barrier. Air leakage testing is to be carried out on a specified test area of the exterior wall construction. The test area may remain as part of the new building construction provided it is acceptable. These inspections are intended to ensure quality control of the installed air/vapour barrier system.

.2 The inspection and testing program shall address air tightness, bond strength, and readiness of substrate for application of air/vapour barrier membranes. Testing of the exterior wall construction shall comply with the 1995 NBC. The maximum air leakage rate is to be 0.05 $L/s/m^2$) at 75 Pa. The standard for the exterior wall construction is to be based upon satisfactory test results of the test area of the exterior wall construction.

Adhesion testing must show 6 psi minimum.

.3 The City or Contract Administrator may demand verification of the Work on any section of a wall or surface by an infiltration test, carried out by an accredited company. This test shall be used to confirm the quality of materials, installation, and elements affecting the proper functioning of the air/vapour barrier system. The cost of carrying out this test shall be paid by the City.

END OF SECTION

RIGID WALL INSULATION, MOISTURE BARRIER, SHEET AIR / VAPOUR BARRIERS

1. GENERAL

1.1 Work Included

.1 Perimeter foundation insulation.

.2 Exterior wall insulation

.3 Sheet air/vapour barrier.

1.2 References

.1 American Society for Testing and Materials (ASTM) D2842 - Water Absorption of Rigid Cellular Plastics.

.2 Canadian Government Specification Board (CGSB) 51-GP-20M - Thermal Insulation, Expanded, Extruded Polystyrene.

.3 CGSB 51-GP-21M - Thermal Insulation, Urethane and Isocyanurate.

1.3 Testing

.1 Testing of the air barrier system will be performed by a testing agency appointed and paid for by the Purchaser.

.2 Performance of the air barrier system will be evaluated with respect to Part 5 of the National Building Code of Canada (NBC) 1995 and as amended by the Manitoba Building Code 1998.

2. PRODUCTS

2.1 Materials

.1 Thermostud channel: Available from Construction Products Division, W.R. Grace & Co. of Canada, Ltd.

2.2 Moisture Barrier

.1 Moisture Barrier for Below Grade Application: Bithuthene 3000.

2.3 Board Insulation

.1 Rigid Insulation (foundation): CGSB 51-GP-20M, Type 4, extruded cellular polystyrene, square edges: Celfort by Celfortec; thickness as indicated on Drawings.

.2 Rigid Insulation (walls): Glass fibre reinforced polyisocyanurate foam core with reflective foil facer on both sides. 610 mm wide boards. Thickness as indicated on Drawings. Thermax as manufactured by Celotex.

.3 Rigid Insulation (roof): CGSB 51-GP-20M, Type 4, extruded cellular polystyrene, square edges: 'Roofmate' as manufactured by Dow. Thickness as indicated on Drawings

2.4 Air / Vapour Barrier

.1 Membrane type (wall to foundation): Self-Adhesive: SBS modified bitumen membrane reinforced with glass scrim; 1mm thick minimum; Blueskin SA. Primer to membrane Manufacturers' recommendations. Sealant: To membrane Manufacturers' recommendations. Primer: To membrane Manufacturers' recommendations.

3. EXECUTION

3.1 Preparation

.1 Verify substrate and adjacent materials and insulation boards are dry and ready to receive insulation and adhesive.

.2 Verify substrate surface is flat, free of honeycomb, fins, irregularities and material that will impede adhesion of insulation.

.3 Verify insulation boards are unbroken, free of damage, with face membrane undamaged.

.4 Verify surfaces within walls being insulated have been inspected and accepted.

3.2 Vapour Barrier – Concrete Block Walls

.1 Prime surfaces to membrane Manufacturers' recommendations.

.2 Apply membrane to Manufacturers' recommendations.

.3 Apply membrane horizontally starting at bottom of wall and weather lap 50 mm.

.4 Lap ends 50 mm.

.5 Roll membrane, including seam, with hand roller to ensure full contact.

.6 Cut membrane neatly around projections to form a tight seal. Seal area around any projections with application of sealant.

.7 Seal membrane where it meets the substrate, at the end of the days Work.

3.3 Board Insulation – Foundation Walls

.1 Install insulation vertically.

.2 Butt edges and ends tight to adjacent board, protrusions or steel studs.

.3 Ensure boards are fitted tight to vapour barrier leaving no voids at joints.

.4 Weatherlap insulation joints.

END OF SECTION

MODIFIED BITUMINOUS MEMBRANE ROOFING

1. GENERAL

1.1 Work Included

.1 Conventional, 2-ply, modified bituminous roofing.

1.2 References

.1 CAN2-51.32M – Sheathing, Membrane, Breather Type

.2 CGSB 51-GP-20M – Thermal Insulation Extruded, Expanded Polystyrene

1.3 System Description

.1 Conventional roof system: two-ply torched on conventional SBS membrane system with insulation and gypsum board on steel deck.

1.4 Qualifications

.1 Applicator: company specializing in performing the Work of this Section with three (3) years documented experience and approved by system Manufacturer.

.2 Work of this Section to conform to Manufacturer's instructions.

1.5 Manufacturer's Representative

.1 The roofing material Manufacturer shall delegate a representative to visit the Work at commencement of Work and periodically during Work in progress.

.2 At all times permit and facilitate access to the Work Site and roofs to the Manufacturer's Representative.

1.6 Delivery, Storage, and Handling

.1 Deliver, store, protect, and handle Products to Site under provisions of the General Specifications Section.

.2 Deliver Products in Manufacturer's original containers, dry, undamaged, seals and labels in tact.

.3 Store Products in weather-protected environment, clear of ground and moisture.

.4 Stand roll materials on end.

1.7 Environmental Requirements

.1 Do not apply roofing membrane during inclement weather.

.2 Do not apply roofing membrane to damp or frozen deck surface.

.3 Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day.

1.8 Warranty

.1 Provide warranty in accordance with General Specification but for a period of five (5) years.

2. PRODUCTS

2.1 Membrane Materials

.1 Membrane Air/Vapour Barrier: Soprema, torch-on.

.2 Membrane Base Sheet, Base and Cap Sheet Flashing: Soprema Sopralene Flam 180.

.1 Description: Roofing membrane with a non-woven polyester reinforcement and thermofusible SBS modified bitumen. Both sides shall be protected by a thermofusible plastic film. This membrane is to be applied by torching only.

.2 Components:

.1 Reinforcement: non-woven polyester, 180 g/m^2

.2 Thermofusible elastomeric bitumen: mix of selected bitumen and SBS thermoplastic polymer.

.3 Membrane Cap Sheet Flashing: Soprema Sopralene Flam 250 GR.

.1 Description: Roofing membrane with a non-woven polyester reinforcement and thermofusible SBS modified bitumen. The top side shall be self-protected with coloured granules. The underside shall be protected by a thermofusible film. This membrane is to be applied to torching only.

.2 Components:

.1 Reinforcement: 250 g/m^2 of non-woven polyester

.2 Elastomeric asphalt: mix of selected bitumen and SBS thermoplastic polymer.

.4 Torchable Self-Adhesive Membrane: “Sopraflam”.

2.2 Sheet Materials

.1 Fibreboard Protection Board: to CSA-A247-M, Type 2, 13 thick, asphalt impregnated.

.2 Gypsum Board: CSA A82.27, Sheathing grade, 13 thick, uncoated faces, fire rated.

.3 Torchable Overlay: Recovery Board "Sopraboard" (two (2) layers as per Drawings, thickness as indicated.

2.3 Insulation

.1 CGSB 51-GP-20M, Flat, Type 4 extruded polystyrene board with skin surface, Roofmate by Dow Chemical. Total thickness of 125 mm. Other acceptable Manufacturers: Celfortec.

.2 Sloped, Type 2 expanded polystyrene board. Minimum thickness: 13mm. Acceptable Manufacturers: Dow Chemical, Celfortec.

3. EXECUTION

3.1 Preparation

.1 Gypsum Board: Screw gypsum board to metal deck. Butt ends and edges tight. Butt ends over firm bearing.

.2 Insulation: Install two (2) layers of insulation, maximum thickness of 75 mm per layer; stagger joints of second layer with joints of first layer. Butt insulation tight with adjacent boards at all edges.

.3 Protection Board: Mop on one layer of fibreboard. Offset joints of fibreboard with joints of insulation.

.4 Torchable Board: Mop on one layer of Recovery Board.

3.2 Roof Membrane

.1 Install roofing membrane to Manufacturer's written instructions.

.2 Base Sheet Installation:

.1 Base sheet membrane shall be unrolled dry on torchable overlay panels for alignment.

.2 Base sheet shall be torch welded on torchable overlay, in accordance with recommendations of the membrane Manufacturer. Base sheet shall have side laps of 75 mm and end laps of 150 mm.

.3 Make sure the membrane is properly welded, without air pockets, wrinkles, fishmouths, or tears.

.4 Torch welding speed varies depending on the weather. In cold conditions, it slows down, in warm and dry conditions, it speeds up.

.3 Base Sheet Flashing Installation:

.1 Surface where membrane is applied shall receive an asphalt primer coating at the rate of 0.25 L/m^2. Primer must be dry before application of the base sheet flashing.

.2 Base sheet shall be laid in strips 1 m wide to the vertical surfaces, extending on to the flat surface of the roof a minimum of 100 mm. Side laps shall be 75 mm and shall be staggered a minimum of 100 mm with the laps of the base sheet in order to avoid excessive thickness.

.3 Base sheet shall be torch welded directly on its support from bottom to top. Torch welding shall soften the underside of the base sheet without overheating, resulting in a uniform adhesion over the entire surface. When allowed by the support, the base sheet top edge shall be nailed on 300 mm centres.

.4 Cap Sheet Installation:

.1 Once the base sheet and stripping has been applied and does not show any defects, the cap sheet can then be laid.

.2 Cap sheet shall be unrolled starting from the lowest point of the roof. Cap sheet shall be rerolled from both ends prior to torching. Care must be taken to ensure alignment of the first roll (parallel with the edge of the roof).

.3 Cap sheet shall be torch welded on to the base sheet membrane. During this application, both surfaces shall be simultaneously melted, forming an asphalt bead that shall be pushed out in front of the cap sheet.

.4 Avoid overheating.

.5 Base sheet and cap sheet shall be staggered a minimum of 300 mm.

.6 Cap sheet shall have side laps of 75 mm and end laps of 150 mm.

.7 Make sure the two (2) membranes are properly welded without unwelded areas.

.8 After installation of the cap sheet, check all lap seams on the cap sheet.

.9 For aesthetics, care should be taken to avoid excessive asphalt seepage along the joints.

.5 Cap Sheet Flashing Installation:

.1 Cap sheet stripping shall be laid in strips 1 metre wide. There must be at least 150 mm of cap sheet overlap on the deck. Side laps shall be 75 mm and shall be staggered a minimum of 100 mm from cap sheet laps and base sheet laps, in order to avoid excessive thickness.

.2 Cap sheet stripping shall be torch welded directly on its base sheet, proceeding from bottom to top. Torching shall soften the two membranes and ensure a uniform weld. Use a degranulator.

.6 Walkway Installation:

.1 Install over addition cap sheet (granulated) ply.

.2 Install adhesive between 10° to 35°C and as per Manufacturer's instructions.

3.3 Cleaning

.1 Remove bituminous markings from finished surfaces.

.2 In areas where finished surfaces are soiled caused by Work of this Section, consult Manufacturer of surfaces for cleaning advice and conform to their documented instructions.

.3 Repair or replace defaced or disfigured finish due to Work of this Section.

3.4 Protection

.1 Protect building surfaces against damage from roofing Work.

.2 Where traffic must continue over finished roof membrane, protect surfaces.

3.5 Coordination with Other Trades

.1 Coordinate with electrical and mechanical sub-trades for making all penetrations through roofing weather and moisture tight.

END OF SECTION

SHEET METAL FLASHING

1. GENERAL

1.1 Work Included

.1 Parapet cap flashings.

.2 Base/drip flashings.

1.2 Reference Standards

.1 CRCA - Canadian Roofing Contractors Association.

.2 American Society for Testing and Materials (ASTM) A525 - Sheet Steel, Zinc Coated, Galvanized by the Hot-Dip Process.

.3 Canadian Government Specification Board (CGSB) 37-GP-5M - "Sealing Compound, Rubber Asphalt".

1.3 Existing Conditions/Protection

.1 Exercise care when working on or about roof surfaces to avoid damaging or puncturing membrane or flexible flashings.

.2 Place plywood panels on roof surfaces to Work of this Section and on access routes. Keep in place until completion of Work.

2. PRODUCTS

2.1 Sheet Metals

.1 Galvanized steel: minimum 24 ga. core steel; conforming to requirements of ASTM A525 G90 Galvanized Coating.

.2 Prefinished galvanized flashing: ASTM A446; G90 zinc coating; 24 ga. core steel; shop precoated; Colour as per schedule.

2.2 Accessory Materials and Components

.1 Fasteners: concealed clip type, of same materials as flashings; sized to suit application.

.2 Rubber-Asphalt Sealing Compound: conforming to requirements of CGSB 37-GP-5M.

.3 Bituminous paint: acid and alkali resistant type; black colour.

2.3 Fabrication

.1 Fabricate metal flashings in accordance with recommendations of CRCA and as indicated on Drawings.

.2 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.3 Form sections in 8 foot lengths. Make allowances for expansion at joints.

.4 All seams are to be flat lock type except corners. Fabricate corners minimum 460 mm, mitred, soldered or welded, and sealed as one (1) piece.

.5 Hem exposed edges of flashings on underside 13 mm.

.6 Backpaint flashing with bituminous paint where expected to be in contact with cementitious materials or dissimilar metals. Fabricate scuppers as detailed.

3. EXECUTION

3.1 Examination

.1 Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place, and nailing strips located.

.2 Verify membrane termination and base flashings are in place, sealed, and secure.

.3 Beginning of installation means acceptance of existing conditions.

3.2 Preparation

.1 Field measure Site conditions prior to fabricating Work.

.2 Install starter and edge strips, and cleats before starting installation.

3.3 Installation

.1 Install flashings in accordance with CRCA recommendations and as indicated on Drawings.

.2 Secure flashing in place using concealed type fasteners. Use exposed fasteners in locations approved by Engineer only. When using exposed fasteners, they are to be of the same finish as flashings.

.3 Apply sealing compound at junction of metal flashings and asphalt felt flashings.

.4 Lock seams and end joints. Fit flashing tight in place. Make corners square, surfaces true and straight in all planes and all lines accurate to profiles.

.5 Counter-flash all mechanical and electrical items projecting through.

.6 Install galvanized flashing to all locations indicated on Drawings.

.7 Install pre-finished flashing to all locations indicated on Drawings.

.8 Seal metal joints watertight.

END OF SECTION

SEALANTS AND CAULKING

1. GENERAL

1.1 Work Included

.1 Supply and installation of all sealant and backing materials as required.

1.2 Environmental Conditions

.1 Sealant and substrate materials to be minimum 5°C.

.2 Should it become necessary to apply sealants below 5°C, consult sealant Manufacturer and follow their recommendations.

1.3 Reference Standards

.1 Canadian Standards Association (CAN) 19-GP-13M - Sealing Compound, One Component, Elastomeric, Chemical Curing.

.2 Canadian Government Specification Board (CGSB) 19-GP-22M - Sealing Compound, One Component, Silicone Base, Chemical Curing - Mildew Resistant.

.3 CGSB 19-GP-17M - Sealing Compound, One Component, Acrylic Emulsion Base.

1.4 Warranty

.1 Provide warranty in accordance with General Specification, but for three (3) years.

.2 Warranty: Include coverage of installed sealants and accessories which fail to achieve air tight and watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

2. PRODUCTS

2.1 Materials

.1 Primers: type recommended by sealant Manufacturer.

.2 Joint Fillers:

.1 General: compatible with primers and sealants, outsized 30 to 50%.

.2 Polyethylene, urethane, neoprene or vinyl: extruded closed cell foam, Shore A hardness 20, tensile strength 140 to 200 kPa.

.3 Neoprene or butyl rubber: round solid rod, Shore A hardness 70.

.4 Polyvinyl chloride or neoprene: extruded tubing with 6mm minimum thick walls.

.5 Impregnated precompressed polyurethane foam sealant tape. Acceptable Product: Emseal "Grayflex".

.3 Bond Beaker: pressure sensitive plastic tape, which will not bond to sealants.

.4 Sealants:

.1 Sealant shall be ultraviolet (UV) resistant and ozone resistant, capable of supporting their own weight: conforming to CAN2-19.13.

.2 Sealants for vertical and horizontal non-traffic bearing joints, to Table 1, CGSB19-GP-23.

.3 Colour of sealants: to match adjacent surface. Colours to be selected by the Contract Administrator, form standard colour range.

.4 Joint Cleaner: xylol, methylethyleketon or non-corrosive type recommended by sealant Manufacturer and compatible with joint forming materials.

2.2 Acceptable Products

.1 For all non-traffic bearing joints unless indicated otherwise Dow Corning No. 790.

.2 For joints between exterior doors, windows, ductwork, etc., and adjacent materials: Dow Corning No. 795.

3. EXECUTION

3.1 Preparation

.1 Remove dust, paint, loose mortar and other foreign matter. Dry joint surfaces.

.2 Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sandblasting.

.3 Remove oil, grease, and other coatings from nonferrous metals with joint cleaner.

.4 Prepare concrete, glazed, and vitreous surfaces to sealant Manufacturer's instructions.

.5 Examine joint sizes and correct to achieve depth ratio one-half of joint width with minimum width and depth of 6 mm, maximum width 25 mm.

.6 Install joint filler to achieve correct joint depth.

.7 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.

.8 Apply bond breaker tape where required to Manufacturer's instructions.

.9 Prime sides of joints in accordance with sealant Manufacturer's instructions immediately prior to caulking.

3.2 Application

.1 Apply sealants, primers, joint fillers, bond breakers, to Manufacturer's instructions. Apply sealant using gun with proper size nozzle. Use sufficient pressure to fill voids and joints solid. Superficial pointing with skin bead is not acceptable.

.2 Apply sealant to joints between door, window frames to adjacent building components, around perimeter of every external opening, to control joints in concrete slabs and where indicated.

END OF SECTION

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DIVISION 08

Reviewed and Approved

Date

METAL DOORS & FRAMES

1. GENERAL

1.1 Work Included

.1 Non-rated and fire rated rolled steel frames.

.2 Non-rated and fire rated hollow steel doors.

.3 Interior window frames.

1.2 Related Sections

.1 Door Hardware: Section 08700

.2 Painting: Field painting of frames: Section 09900.

.3 Electrical: Electrical Hardware: Division 16

1.3 References

.1 Canadian Steel Door and Frame Manufacturers Association - Manufacturing Standard for Steel Doors and Frames.

.2 Canadian Steel Door and Frame Manufacturers Association - Canadian Fire Labelling Guide for Steel Doors and Frames.

1.4 Quality Assurance

.1 Conform to requirements of Canadian Steel Door and Frame Manufacturers Association Standards.

.2 Fire rated construction to conform to Underwriters Laboratories of Canada (ULC) standards.

1.5 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data to requirements of Section 01300.

.2 Indicate on Shop Drawings, frame configuration, anchor types and spacings, location of cutouts for hardware, reinforcement and finish.

.3 Indicate on Shop Drawings, door elevations, internal reinforcement, and closure method, and location of cutouts for glazing.

2. PRODUCTS

2.1 Acceptable Manufacturers

.1 Macotta

.2 Allmar

.3 Shanahans

2.2 Frames

.1 Type/Size: as shown on Drawings and Schedules.

.2 Frames: 1.52 mm (16ga.) cold rolled sheet steel with ZF75 Colourbond coating.

.3 Bumpers: Resilient rubber.

.4 Anchors: purpose made to rigidly secure frames, 3 per jamb.

.5 Mortar Guard Boxes: 0.76 mm (22 Ga.) welded in place.

.6 Primer: zinc chromate type.

.7 Insulation: Fibreglass

2.3 Doors

.1 Insulated Core Doors: minimum 1.21 mm (18 Ga.) surface sheets, and top and bottom end channels; cores filled with insulation.

.2 Honeycomb Core Doors: minimum 1.21 mm (18 Ga.) surface sheets and 1.21 mm (18 Ga.) thick top and bottom end channels; cores filled with honeycomb material laminated under pressure to surface sheets.

.3 Reinforcement for hardware:

.1 Locks: minimum 1.52 mm (16 Ga.) steel.

.2 Butts: minimum 3.42 mm (10 Ga.) steel.

.3 Flush Bolts: minimum 3.42 mm (10 Ga.) steel

.4 Door Closures: minimum 1.9 (14 Ga.) mm steel.

.5 Door Holders: minimum 1.9 mm (14 Ga.) steel.

.4 Glazing Stops: minimum 0.91 mm (14 Ga.) rolled steel channel shape, butted corners; 16 mm high profile; prepared for countersink screws.

.5 Glazing: as per Section 08800.

2.4 Fabrication - Frames

.1 Fabricate frames as welded unit.

.2 Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

.3 Prepare frame for silencers. Provide three (3) single silencers for single doors and mullions of double doors on strike side, and two single silencers on frame head at double doors without mullions.

.4 Attach channel spreaders at bottom of frames for shipping.

.5 Reinforce exterior frames at lock side, to prevent frame distortion.

2.5 Fabrication -Doors

.1 Fabricate hollow metal doors and panels in accordance with requirements of "Canadian Manufacturing Standards for Steel Doors and Frames" produced by the Canadian Steel Door and Frame Manufacturer's Association and as indicated on Drawings.

.2 Fabricate fire rated hollow metal doors in accordance with requirements of ULC. Place ULC labels where visible when in installed position.

.3 All doors in fire rated walls shall be listed and labelled with a maximum temperature rise limitation of 250°C after 30 minutes in accordance with the National Building Code.

.4 Mechanically interlock longitudinal seams of honeycomb core type doors weld seams and sand flush. Top and bottom of doors closed with end channels recessed and spot welded in place.

.5 Reinforce and prepare doors to receive hardware. Refer to Section 08700 for hardware requirements.

.6 Each exterior hollow metal door to be supplied complete with a full length 3.42 mm (10 Ga.) anti-intrusion plate welded to latch side of door.

2.6 Roll-up Doors

.1 Steel exterior & interior skin: minimum .4mm, roll-formed, hot-dipped galvanized, painted; foamed in place polyurethane core. Section to have nominal thickness of 41mm with an EPDM thermal break.

.2 Insulation to have thermal resistance of: 2.63 W/m^2 (R14.86).

.3 End Stiles: 16 Ga steel

.4 Springs: 25,000 cycles.

.5 Track: 51mm angle mounted

.6 Lock: interior mounted slide lock

.7 Weatherstrip:

.8 Finish:

.9 Operation: Chain Hoist with electric operator, 0.56 kW (0.75 hp)

.10 Standard of Acceptance: Thermacore Series 591, as manufactured by Overhead Door Corporation.

3. EXECUTION

3.1 Installation

.1 Install doors and frames in accordance with Canadian Steel Door and Frame Manufacturers Association standards.

.2 Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

.3 After installation, touch up all scratched or damaged surface and prime.

.4 Insulate all frames exposed to the exterior.

3.2 Tolerances

.1 Maximum Diagonal Distortion: 2 mm measured with straight edge, corner to corner.

END OF SECTION

DOOR HARDWARE

1. GENERAL

1.1 Work Included

.1 Hardware for hollow metal doors.

.2 Thresholds and weatherstripping.

1.2 Related Sections

.1 Metal Doors and Frames: Section 08100

1.3 References

.1 Underwriters Laboratories of Canada (ULC) - List of Equipment and Materials, Volume 2.

1.4 Coordination

.1 Coordinate Work of this Section with other directly affected Sections involving Manufacturer of and internal reinforcement for door hardware.

.2 Supply templates to Manufacturers of components affected by hardware.

1.5 Regulatory Requirements

.1 Conform to applicable code for requirements applicable to fire rated doors, frames and hardware.

.2 Conform to ULC requirements for fire rated doors, frames and hardware.

1.6 Shop Drawings

.1 Submit Shop Drawings to requirements of Section 01300.

.2 Indicate on Shop Drawings, locations and mounting heights of each type of hardware.

.3 Hardware list shall list each door individually and shall list hardware for each door as a described item, not by a code as is done in the Specification. Hardware list shall be in terminology understandable by a layman.

.4 Supply templates to door and frame Manufacturer to enable accurate sizes, locations of cut outs, and reinforcement for hardware.

.5 Provide Product data on specified hardware as requested.

.6 Submit one (1) copy of Manufacturers' catalogue cuts of each item, with hardware list.

.7 Put parts lists, Manufacturer's instructions, and catalogue cuts into maintenance manual as per Section 01300.

1.7 Delivery and Storage

.1 Store hardware in locked, dry area in individual packages or like groups.

2. PRODUCTS

2.1 Materials

.1 As per schedule at end of Section.

.2 Use one (1) Manufacturer's Products only for all similar items.

2.2 Door Hardware

.1 Butts: Provide 1-1/2 Pair for all doors, except doors over 900 mm wide or over 2,200 mm high are to have two (2) pair.

.2 Protective Plates: supply to both sides of door unless otherwise specified.

2.3 Fasteners

.1 Supply all fastening devices for installation and operation of hardware.

.2 All exposed fasteners to be finished to match hardware.

.3 Use fasteners compatible with material through which they pass.

2.4 Keying

.1 Door locks: allow for a grand master key system to match existing system.

.2 Supply three (3) keys for each lock. Supply three (3) master keys for each group, and three (3) grand master keys.

.3 Key to City's existing G.M.K. system.

3. EXECUTION

3.1 Inspection

.1 Verify that door and frame components are ready to receive Work and dimensions are as required.

.2 Beginning of installation means acceptance of existing conditions.

3.2 Installation

.1 Install hardware in accordance with Manufacturer's instructions.

.2 Use the templates provided by hardware item Manufacturer.

.3 Maintain the following mounting heights for doors, from finished floor to centre line of hardware item:

.1 Locksets: 1,020 mm

.2 Dead Locks: 1,525 mm

.3 Exit Devices: 1,020 mm

3.3 Schedule

.1 Refer to Architectural Drawings.

END OF SECTION

GLASS AND GLAZING

1. GENERAL

1.1 Work Included

.1 Glass and glazing for hollow metal frames and screens and hollow metal doors, hollow metal windows.

1.2 Related Sections

.1 Metal Doors and Frames: Section 08100

1.3 Reference Standards

.1 Canadian Government Specification Board (CGSB) 12-GP-1M - "Glass, Safety, Tempered or Laminated"

.2 CGSB 12-GP-3M - "Glass, Polished Plate or Float, Flat, Clear"

.3 CGSB 19-GP-11M - "Glass, Wired, Safety"

2. PRODUCTS

2.1 Glass

.1 Float Glass: glazing quality, conforming to CGSB 12-GP-3M; of thickness determined by size of glazed openings.

2.2 Glazing Materials

.1 Glazing tape: performed butyl type, Tremco 440 tape; paper release.

.2 Setting Blocks: neoprene; 70-90 durometer hardness; 100 mm long x 10 mm thick x 6 mm high.

.3 Spacer Shims: neoprene; 50 durometer hardness; 75 mm long x 3 mm thick x 6 mm high.

.4 Sealant: Tremglaze as manufactured by Tremco.

3. EXECUTION

3.1 Interior Combination Method (Tape/Tape)

.1 Cut glazing tape to proper length and install against permanent stop, projecting 1.5 mm above sightline.

.2 Place setting blocks at 1/4 point.

.3 Rest glass on setting blocks and push against tape with sufficient pressure to ensure full contact and adhesion at perimeter.

.4 Place glazing tape on free perimeter of glass in same manner described above.

.5 Install removable stop, avoid displacement of tape, exert pressure on tape for full continuous contact.

.6 Knife trim excess or protruding tape.

3.2 Cleaning

.1 After installation mark glass with an "X" by using tape or removable paste.

.2 Immediately remove droppings from finished surfaces. Remove labels after Work is completed.

END OF SECTION

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DIVISION 09

Reviewed and Approved

Date

STUCCO SYSTEM

1. GENERAL

1.1 Work Included

.1 Provide all labour, materials, methods, equipment, accessories to complete exterior wall stucco systems.

.1 Exterior stucco systems with coloured finish coats

.2 Metal suspension system, metal lath, metal furring, reinforcing mesh.

.3 Metal accessories, trims, control joints.

1.2 Related Documents

.1 Drawings, General Conditions and Divisions 1, 6, 7, and 9.

1.3 Samples

.1 Submit samples of any and all materials, stucco finishes requested, prepaid to Contract Administrator's office.

.2 Submit sample panels of stucco pattern, colours, finish for Contract Administrator approval prior to application, as finished Work standard.

1.4 Codes/Standards

.1 .Perform lath, stucco, cement plaster parging Work to Canadian Standards Association (CSA) A82.30-M1980.

1.5 Materials Delivery, Storage, and Handling

.1 Deliver, store cement, lime, other manufactured materials in unbroken bags, barrels, packages, suitable containers, plainly marked prevent, labeled with Manufacturer's name and brand.

.2 .Deliver, handle materials to prevent inclusion of foreign material, damage of materials by water, or breakage.

.3 Protect perishable materials, store in weathertight structures on floors maximum 300 mm above adjoining grade.

.4 Store aggregates in clean bins, on platforms having hard clean surfaces. Use positive means to prevent inclusion of foreign materials.

.5 Remove hardened or partially set cement, other cementious materials from Site.

.6 Thaw frozen aggregates before using. Permit aggregates (and aggregates produced or manipulated by hydraulic methods) to drain for twelve (12) hours before use.

1.6 Environmental Requirements

.1 Use only unfrozen materials. Apply cement stucco only to substrates free of frost.

.2 Perform, maintain cement stucco Work at ambient and substrate temperature above 50°C, below 380°C minimum twenty-four (24) hours prior, during application and for twenty-four (24) hours after.

.3 Stop cement stucco, parging Work when ambient temperature might be expected to drop below 50°C within four (4) weeks after application.

2. PRODUCTS

2.1 Materials

.1 Water: to CSA A 179-M1976, clean, fresh, potable, free of acid, alum, oils, alkalies, salts, organic or mineral matter, other deleterious substances.

.2 Portland cement: to CAN/CSA –A5/A8/A362-M88, normal, type 10.

.3 Sand aggregate: to American Society for Testing and Materials (ASTM) C897, CSA A82.57-M1977 (R9184), Table 1, approved colour, natural or manufactured, fresh water washed.

.4 Bonding agent: to ASTM C932, non-oxidizing, non-crystallizing, to improve bond strength, adhesion.

.5 Finish Coat: 'Knock-down' Finish, Custom colour additives: pre-manufactured precision formulated custom colour pigments in dry powder form for addition to Imasco Premix 1000 stucco finish coat mixes, two (2) colours to be selected by Contract Administrator.

.6 Metal lath: to ASTM C841, CSA A82.30-M1980, Table 1 self-furring, diamond mesh, 1.85 kg/m^2 (3.4 lb./sq yd), galvanized.

.7 Tie wire: No. 16 gauge galvanized soft annealed steel.

.8 Fasteners: to CSA B111, screw type, corrosion resistant, galvanized, minimum 13 mm dia., sizes required to secure lath, sufficient length to penetrate insulation thickness, gypsum wallboard, 1" into steel stud, steel furring systems, to securely retain lath to Contract Administrator approval.

.9 Metal accessories, trim: to CSA A82.30, base screeds, cornerite, casing beads, control/expansion joints, perimeter vented reveal edge mouldings, perforated embedment

flanges, interior corner reinforcement, weep and drip screeds, reveals, etc. as required to complete stucco installations.

2.2 Stucco, Cement Parging Mixes

.1 Mix stucco, cement plaster parging in accordance with CSA A82.30-1980.

.2 Mechanically mix exterior wall stucco systems base coats, finish coats in strict accordance with Manufacturer instructions, their field representative directions.

3. EXECUTION

3.1 Protection

.1 Do not stucco, plaster adjacent to aluminum, masonry, other finished Work until such Work is masked. Protect completed Work, other Sections Work form marking, staining, other damage, etc. use non-staining covers.

.2 Provide adequate protection from contaminates and weather for substrates prior to stucco applications, to stucco applications. Maintain in place until stucco cured.

3.2 Preparation

.1 Obtain, make ready, prepare all materials. Cause no delay to scheduling.

.2 Prepare surfaces to receive stucco finishes, cement plaster to CSA A82.30.

.3 Ensure grounds, screeds, beads, accessories, expansion/control joints, etc. in place.

.4 Ensure insulation properly installed, exterior building paper applied prior to lath application.

.5 Report any unsatisfactory conditions to Contract Administrator in writing. Commence Work when unsatisfactory conditions corrected.

3.3 Metal Lath

.1 Apply metal lath horizontally over building paper, secure to Insulok channels of insulation system where indicated with approved metal screw fasteners 600 mm o.c. horizontally, 150 mm o.c. vertically, at each bearing.

.2 Apply metal lath horizontally over Tyvek, to wood stud framing through sheathing with approved metal screw fasteners 400 mm o.c. horizontally, 150 mm o.c. vertically, at each bearing.

.3 Apply metal lath horizontally over insulation, wood blocking to depth below grade indicated, minimum 300 mm, secure to concrete grade beams, walls with approved large head nails to wood blocking 400 mm o.c. horizontally, 150 mm o.c. vertically.

.4 Apply lath with long dimension at right angle to bearing, end joints over framing members. Lap all joints not less than 50 mm. Stagger end joints. Wire tie ends joints 100 mm o.c.

.5 Reinforce exterior, interior corners diagonally at each corner of openings exceeding one sq. ft. with vertical strips of wire lath. Internal corners. Do not use No. 1A expanded corner beads for exterior corners. Lath across dissimilar substrate junctures with minimum 200 mm wide lath strips.

3.4 Stucco Trim, Accessories, Etc. Installation

.1 Erect trims, accessories, etc. straight, plumb, level, rigid, at proper plane, in full lengths, secure at maximum 200 mm o.c.

.2 Install plaster stops, make trowel cuts to provide 6 mm clearance where objects penetrate through, into stucco, cement plaster parging to allow unrestricted shrinkage. Fully seal with back-up rod, approved caulking. Provide plaster stops where stucco, cement plaster parging abuts other materials, surfaces.

3.5 Control, Expansion Joint Installation

.1 Locate control/expansion joints at dissimilar materials, building expansion/control joints, wall spacing indicated, as required by Contract Administrator.

.2 Apply stucco system to clean, adequately prepared surfaces free from dust, dirt or other deleterious substances.

.3 Prepare, mix, apply 19 mm thick Greatwall Basecoat Concentrate system in strict accordance with Imasco Minerals Inc. written instructions, recommendations.

.4 Apply stucco base coats to entire wall surfaces interrupted only at junctions of plaster planes, at openings, control joints in on continuous operation using trowel or machine.

.5 Apply scratch coat to completely embed lath to minimum thickness 10 mm, allow 3 mm shallow scoring of surface. Allow to stiffen on wall surfaces, hard and rigid on horizontal soffit surfaces.

.6 Apply brown coat to maximum 10 mm thickness over fine spray dampened scratch coat with sufficient pressure to ensure tight, uniform bond to scratch coat, to bring combined total thickness to 19 mm.

.7 Rod brown coat to true, even plane, filling surface defects. Trowel float surfaces uniformly after it has set, when moisture still present.

.8 Moist cure stucco base coats if required by climatic conditions to maintain uniformly moist for minimum 48 hours. Provide adequate protection to retard evaporation when extreme conditions, hot, dry, windy weather occur. Use plastic sheets, other approved coverings.

.9 Prepare, mix, apply stucco finish coat systems in strict accordance with Imasco Minerals Inc. written instructions, recommendation.

.10 Install finish coat systems with enough workers to apply material in one continuous operation to finish entire sections of wall, soffit areas at one time. Interrupt applications only at natural breaks, expansion joints, change of plane, etc.

.11 Avoid application of separate batches of finish side by side, in direct sunlight or excessive wind, late in day if dew imminent, temperature below 50°C in twenty-four (24) hours.

.12 Spread on even coat of finish coat material using a trowel, always working away from a wet edge.

.13 Use pairs of applicators with first person applying finish, second person floating or trowelling finish to desired texture.

.14 Cure applied finish coat materials in strict accordance with Imasco Minerals Inc. system requirements.

.15 Provide adequate protection, including plastic sheet coverings, to retard evaporation when extreme conditions occur.

.16 Allow finish coat “Premix 1000” a minimum of twenty-four (24) hours to set, with sufficient moisture retained, applied for proper hydration, prevent shrinkage.

3.6 Clean-up

.1 Clean-up rubbish, debris, resulting from Work promptly as proceeds, at conclusion, at other times directed by Contractor. Remove from Site.

END OF SECTION

ACOUSTIC CEILING SYSTEMS

1. GENERAL

1.1 Related Sections

.1 Trim for recessed mechanical fixtures: Division 15

.2 Trim for recessed electrical fixtures: Division 16

1.2 References

.1 American Society for Testing and Materials (ASTM) C634 Specifications for Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.

.2 ASTM C636 Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.3 Design Criteria

.1 Maximum deflection: 1/360th of span to ASTM C634 deflection test.

1.4 Samples

.1 Submit samples in accordance with Section 01300.

.2 Submit samples of any and all materials requested.

1.5 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 01300.

.2 Indicate all types of acoustical materials, details of different components of suspension, attachment systems, location, design of tile units, methods of installation.

.3 Show sizes, arrangement of acoustical materials on reflected ceiling plans, relating to lighting fixtures and other items.

1.6 Maintenance Materials

.1 Leave opened cartons surplus panels with the City.

.2 Provide one (1) carton each panel size, type installed for every fifty (50) cartons used or 5% of gross ceiling area for each pattern and type required for project, whichever is greater.

.3 Materials to be the same production run as installed materials.

1.7 Environmental Conditions

.1 Ensure minimum, uniform temperature of 15°C, humidity 20 to 40% before, during, and after installation

.2 Commence installation after building is enclosed, wet Work is completed, and dry.

2. PRODUCTS

2.1 Suspension Systems

.1 No. 1: To ASTM C634, non-fire rated, (2) two directional, exposed tee bar grid consisting of:

.1 Main Tees: Die cut, double web, rectangular bulb, 23.8 mm exposed flanges, with rolled cap, 38 mm deep minimum, cross tee holes 152 mm o.c., integral, reversible splices.

.2 Cross Tees: Die cut, rectangular bulb, 23.8 mm exposed flanges with rolled cap, 32 mm deep minimum, extended web positive interlock to main tee web, lower flange extended, offset.

.3 Edge Mouldings, Trim: Manufacturer's standard to match exposed grid components, uniform width, c/w back-up plates.

.4 Systems Components: 0.55 mm thick commercial quality, cold rolled steel, electro-galvanized coated, prefinished.

.5 Exposed Component Finish: To Canadian Government Specification Board (CGSB) 1-GP-118, factory finished, high grade baked enamel, non-fading, non-yellowing, low gloss.

.6 Colour: Suspension systems, low gloss white.

.7 Hangers: Minimum 2.6 mm thick, galvanized steel wire, minimum 4.8 mm diameter, zinc-coated mild steel pencil rod for required extra support.

.8 Splices, Clips, Retainer Clips, Wire Ties, etc.: To Manufacturer's standard.

.9 Acceptable Manufacturers: CGC Donn Products, Standard "DX Fast-Loc" system, Bailey Metal Products Standard B.E. Stafe-T-Lock system, Chicago Metallic Corp. Standard 200 Snap-Grid system.

2.2 Acoustical Panels

.1 LAT No. 1: To CAN2-92.1-M77, Federal Specifications SS-A-118b Class 25, ULC S-102:

.1 Non-combustible, mineral fibre, 600 x 1200 mm (hard metric), 16 mm thick, square edge, colour white, NRC range 0.55-0.65, STC range 35-39, CGC Interiors manufacture “Auratone, Fissured”.

.2 Use in Suspension System No. 1.

3. EXECUTION

3.1 Installing Suspension System

.1 Erect suspension system grid at heights indicated, to ASTM C636 in accordance with Manufacturer’s printed directions, with skilled mechanics.

.2 Layout ceiling centreline both ways, provide balanced borders at room perimeter as per reflected ceiling plan.

.3 Coordinate suspended systems with location-related components, mechanical, electrical fixtures, etc. Cooperate with Divisions 15 and 16.

.4 Establish ceiling elevation using laser level, transit. Install edge molding to correct ceiling height, at walls, columns, ceiling closures, bulkheads.

.5 Support suspension system main tees at 1,200 mm o.c. maximum, with hanger wire, pencil rod from building structure.

.6 Interlock cross tees to main tees for rigid assembly.

.7 Frame openings for light fixtures, air diffusers, at changes in ceiling heights.

.8 Ensure completed assembly supports all superimposed loads, including panels, appurtenances, and electrical and mechanical fixtures.

.9 Maximum permissible deflection: 1/360 of span.

.10 Set suspension grid Work level to within 3 mm in 3,648 mm.

.11 Ensure straightness, tolerance, bow, camber, twist of any suspension system member does not exceed values in NACA publications.

.12 Sharp local kinks, bends, bruises, dents not accepted.

.13 Level members with supporting hanger tensioned to prevent any subsequent downward movement when ceiling loads imposed.

.14 Do not kink, bend hanger wires to level system tie-in channel.

.15 Install cross tees at right angles to main tees, main tees be non-cumulative.

.16 Ensure no apparent angular displacement one tee to another.

.17 Ensure exposed surface of suspension system level, flush, all joints tight, straight, true.

.18 Install edge mouldings, trim with flush, hairline joints, corners mitred.

.19 Install exposed metal suspension, edge mouldings, trim for louvre ceiling panels, valances.

3.2 Installing Acoustic Panels

.1 Install acoustic panels in suspended grid system, edge panel not less than 50% panel width.

.2 Scribe acoustic panels to fit adjacent Work. Butt joints tight, terminate edges with moulding.

.3 Neatly cut, drill, fit around electrical, mechanical fixtures, other items protruding through acoustical ceilings.

3.3 Cleaning

.1 Touch up scratches, abrasions, voids, and other defects in painted areas.

.2 Clean down all materials, leave free of grime, dirt, fingerprints, other evidence of Work.

END OF SECTION

EPOXY FLOOR COATING STONKOTE GS4

1. GENERAL

1.1 Related Sections

.1	Cast-In-Place Concrete:	Section 03300
.2	Concrete Unit Masonry:	Section 04220
.3	Joint Sealers:	Section 07900

1.2 References

.1 Reference is made to spec standards produced by various organizations to conform to edition of standards specified, or, if not specified, to last edition as amended and revised to date of Contract.

.2	Cure Rate (at 25°C) allow:	4 to 5 hours for tack free surface 24 hours for normal operations
.3	Fire Resistance of Dry Film:	Self Extinguishing
.4	Heat Resistance Limitation:	60°C (for continuous exposure) 93°C (for intermittent exposure)
.5	Percent Solids:	100%
.6	Pot Life @ 25°C:	35 minutes

1.3 Submittals

.1 Product Data: Submit Manufacturer's technical data, installation instructions, and general recommendations for each epoxy flooring material required.

.2 Samples: Submit, for verification purposes, 300 mm x 300 mm square sample of each type of epoxy flooring required, applied to a rigid backing, in colour and finish indicated.

1.4 Quality Assurance

.1 Single Source Responsibility: Obtain primary epoxy flooring materials including primers, resins, hardening agents, finish or sealing coats from a single Manufacturer with not less than ten (10) years of successful experience in manufacturing and installing principal materials described in this Section. Contractor must have completed at least five (5) projects of similar size and complexity. Stonhard or

approved equal. Provide secondary materials only of type and from source recommended by Manufacturer of primary materials.

.2 Arrange a meeting not less than thirty (30) days prior to starting Work.

1.5 Delivery, Storage, and Handling

.1 Deliver material to job Site. Flooring Contractor will check material for completeness and shipping damage prior to job start.

.2 All materials must be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on-site mixing errors. No on-site weighing or volumetric measurements allowed.

.3 Store material in a dry, enclosed area protected from exposure to moisture. Temperature of storage area shall be maintained between 16°C and 32°C.

1.6 Mock-Up

.1 At Site, under Manufacturer's supervision, apply for approval 9 m^2 of complete floor finish in area designated, to match submitted samples. When approved, Site applied sample to be standard for appearance, colour, texture, workmanship, etc., and all Work to conform to this sample.

1.7 Project Conditions

.1 Environment Requirements:

.1 Concrete substrate must be properly cured for a minimum of thirty (30) days.

.2 Temperature: Utilities, including electric, water, heat (air temperature between 16°C and 32°C) and finished lighting to be supplied by General Contractor. Maintain ambient temperature of not less than 18°C and a floor temperature of not less than 16°C from seven (7) days before installation to at least 48 hours after completion of Work and maintain relative humidity not higher than 40% during same period.

.3 Moisture: Ensure substrate is within moisture limits prescribed by flooring Manufacturer.

.4 Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage, and disposal of hazardous materials.

.5 Job area to be free of other trades during, and for a period of twenty-four (24) hours, after floor installation.

.6 Protection of finished floor from damage by subsequent trades is the responsibility of the General Contractor.

.7 Manufacturer's representative must be on job Site at start of installation.

2. PRODUCTS

2.1 Colours

.1 As selected by Contract Administrator from Manufacturer's standard colours.

2.2 Epoxy Floor Coating

.1 100% solids, 0 VOC, two-component general service epoxy coating. Acceptable Manufacturer: Stonhard, STONKOTE GS4

3. EXECUTION

3.1 Preparation

.1 Substrate: Prepare concrete by mechanical means by using a shot blast machine for removal of bond inhibiting materials such as curing compounds or laitance.

3.2 Application

.1 Coating: Mix coating according to Manufacturer's recommended procedures. Squeegee apply and backroll first coat. When surface is tack free, apply second coat to an actual dry film thickness of 200 to 250 microns (8 to 10 mil). Manufacturer: Stonhard, STONKOTE GS4.

.2 Cove base: Height: 150 mm; trowelled epoxy coving.

3.3 Field Quality Control

.1 The right is reserved to invoke the following material testing procedure at any time, and any number of times during period of flooring application.

.2 The City will engage the service of an independent testing laboratory to sample materials being used on the job Site. Samples of material will be taken, identified and sealed, and certified in the presence of the Contractor.

.3 Testing laboratory will perform tests for any of the characteristics specified, using applicable testing procedures referenced herein, or if non-referenced, in Manufacturer's product data.

.4 If test results show materials being used do not comply with specified requirements, Contractor may be directed by the City to stop Work; remove non-complying materials; pay for testing; reapply flooring materials to properly prepared surfaces which had been previously coated with unacceptable materials.

3.4 Curing, Protection, and Cleaning

.1 Cure epoxy flooring materials in compliance with Manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of twenty-four (24) hours.

.2 Protect epoxy flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with Manufacturer's recommendations for protective materials and methods of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.

.3 Cleaning: Remove temporary covering and clean epoxy flooring just prior to final inspection. Use cleaning materials and procedures recommended by epoxy flooring Manufacturer.

END OF SECTION

PAINTING AND FINISHING

1. GENERAL

1.1 Work Included

.1 Prepare surfaces which are to receive finish.

.2 Finish surfaces as indicated in the schedule at the end of this Section.

1.2 Related Sections

.1	Cast-in-Place Concrete:	Section 03300
.2	Concrete Unit Masonry:	Section 04220
.3	Steel Joists:	Section 05210
.4	Metal Deck:	Section 05311
.5	Metal Fabrications: Prime painting:	Section 05500
.6	Epoxy Floor Coating Stonkote GS4	Section 09730
.7	Room Finish Schedule:	Architectural Drawings
.8	Process Piping:	Division 11
.9	Mechanical Piping and Ductwork:	Division 15

1.3 Quality Assurance

.1 Acceptable Manufacturer's, materials, workmanship and all items affecting the Work of this Section is to be in accordance with Canadian Painting Contractors Association (CPCA) Architectural Painting Specification Manual.

.2 Prior to ordering paints, submit to the Contract Administrator for review a complete schedule of paint materials proposed for use. This schedule shall include Manufacturer's name, brand name or code number, type and recommended application.

1.4 Colour Schedule

.1 Paint colours shall be as per room finish schedule and as selected by the Contract Administrator.

.2 Prior to commencement of Work, the Contract Administrator will furnish three (3) copies of colour schedule.

1.5 Samples

.1 Prepare 300 mm x 200 mm samples of paint type finishes when requested by Contract Administrator. Apply finishes on identical type materials to which they will be applied on job.

.2 Identify each sample as to finish, colour name and number and sheen name and gloss units.

1.6 Delivery

.1 Deliver paint materials in sealed original labelled containers, bearing Manufacturers name, type of paint, brand name, colour designation and instructions for mixing or reducing.

1.7 Storage

.1 Provide adequate storage facilities. Store paint materials at a minimum ambient temperature of 8°C and in a well ventilated area.

.2 Take all precautionary measures to prevent fire hazards and spontaneous combustion.

1.8 Environmental Conditions

.1 Ensure surface temperatures or the surrounding air temperature is above 5°C before applying finishes. Minimum application temperatures for latex paints for interior Work is 7°C and for exterior Work 10°C.

.2 Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 7°C for twenty-four (24) hours before, during and forty-eight (48) hours after application of finishes.

.3 Provide minimum 300 Lux of lighting on surfaces to be finished.

1.9 Protection

.1 Adequately protect other surfaces from paint and damage. Make good any damage as a result of inadequate or unsuitable protection.

.2 Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

.3 Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove daily from Site.

.4 Remove all electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored, cleaned and replaced on completion of Work in each area. Do not use solvents that may remove the permanent lacquer finish to clean hardware.

2. PRODUCTS

2.1 Materials

.1 Paint materials to be Products of a single Manufacturer.

.2 All painting materials shall be the best quality and shall be accepted by the Contract Administrator.

.3 Paint shall not be settled, caked or thickened in the container, shall be readily dispersed with a paddle to a smooth consistency, and shall have excellent application properties.

.4 Paint shall arrive on the job colour-mixed except for tinting of undercoats and possible thinning.

.5 All thinning and tinting materials shall be as recommended by the Manufacturer for the particular material thinned or tinted.

.6 Mixed colours shall match colour selection made by the Contract Administrator prior to application of the coating.

.7 Paint shall be ready mixed except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating.

.8 Paint shall have good flow and brushing properties; capable of drying or curing free of streaks or sags.

.9 Paint Accessory Materials: Linseed oil, shellac, turpentine, and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.

.10 Acceptable Manufacturers: Pratt & Lambert, Benjamin Moore, C.I.L.,

3. EXECUTION

3.1 Conditions of Surfaces

.1 Thoroughly examine all surfaces schedule to be painted prior to commencement of Work. Report in writing to the Contract Administrator any condition that may potentially affect proper application. Do not commence until all such defects have been corrected.

.2 Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below maximums established by the paint Manufacturer.

.3 Beginning of installation means acceptance of existing surfaces.

3.2 Preparation of Surfaces

.1 Impervious Surfaces: remove mildew by scrubbing with a solution of T.S.P. and bleach. Rinse with clean water and allow surface to dry completely.

.2 Insulated Surfaces: remove dirt, grease and oil from canvas and cotton insulated coverings.

.3 Aluminum Surfaces scheduled for Paint Finish: remove contamination by steam, high pressure water or solvent washing. Remove acid etch and solvent washing. Apply etching primer immediately following cleaning.

.4 Galvanized surfaces: remove surface contamination and oils from surfaces and wash with solvent. Apply a coat of etching type primer.

.5 Zinc coated surfaces: remove surface contamination and oils from surfaces and prepare for priming in accordance with metal Manufacturers recommendations.

.6 Remove stains caused by weathering of corroding metals from concrete with a solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

.7 Steel and iron surfaces: remove grease, rust, scale, dirt and dust from surfaces. Where heavy coatings of scale are evident, remove by wire brushing, sandblasting or any other necessary method. Ensure all steel surfaces are satisfactory before paint finishing.

.8 Wood Items and Millwork: wipe off dust and grit from all miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks and sappy sections with sealer. Fill all nail holes and cracks after primer has dried and sand between coats. Back prime interior and exterior woodwork.

.9 Unprimed Steel Surfaces: clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to identify defects. Prime paint after defects have been remedied.

.10 Copper Surfaces Scheduled for a Paint Finish: Remove contamination by steam, high pressure water, or solvent washing. Apply vinyl etch primer immediately following cleaning.

.11 Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate, rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

3.3 Applications

.1 Apply paint and other finishes in accordance with good trade practice.

.2 Finishes specified are intended to cover surfaces satisfactorily when applied in accordance with Manufacturer's recommendations.

.3 Apply each coat at the proper consistency.

.4 Each coat of paint is to be slightly darker than the preceding coat unless otherwise acceptable to the Contract Administrator.

.5 Sand lightly between coats to achieve required finish.

.6 Do not apply finishes on surfaces that are not sufficiently dry.

.7 Allow each coat of finish to dry before a following coat is applied, unless directed otherwise by Manufacturer.

3.4 Process, Mechanical, and Electrical Equipment

.1 Refer to Process, Mechanical, and Electrical Sections with respect to painting and finishing requirements.

.2 Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.

.3 Finish paint primed equipment.

.4 Prime and paint insulated and exposed pipes, conduits, boxes, hangers, brackets, collars and supports to match adjacent Work, except where items are plated or pre-finished unless otherwise noted as being painted as separate colour than surrounding Work - refer to Section 15010.

.5 Replace identification markings on mechanical or electrical equipment when painted over or spattered.

.6 Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvres with one (1) coat of flat black paint to limit of sight line. Paint dampers exposed behind louvres, grilles, convector and baseboard cabinets to match face panels.

.7 Paint exposed conduit and electrical equipment occurring in finished areas including baseboard heaters and force flow heaters. Colour and texture are to be selected by Contract Administrator.

.8 Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and before mounting equipment on them.

.9 Colour coding equipment, piping, conduit and exposed ductwork and all colour banding and identification (flow arrows, naming, numbering, etc.) shall be performed to the requirements of Divisions 11 and 15. Piping and ductwork not required to be coded shall be painted in accordance with Mechanical and Process colour schedules.

.10 Paint all exposed exterior mechanical and electrical equipment that has not been factory finished.

.11 Ductwork and piping in truck bay to be finished with epoxy paint.

3.5 Protection

.1 Protect other surfaces from paint or damage. Repair damage.

.2 Furnish drop cloths, shields, and protective methods to prevent spray or droppings from disfiguring other surfaces.

.3 Collect cotton waste, cloths and material which may constitute a fire hazard, place in closed metal containers and remove daily from Site.

3.6 Cleaning

.1 As Work proceeds and upon completion, promptly remove all paint where spilled, splashed or spattered.

.2 During the progress of Work keep the premises free from any unnecessary accumulation of tools, equipment, surplus materials and debris.

.3 Upon completion of Work leave premises neat and clean, to the satisfaction of the Contract Administrator.

3.7 Painting and Finishing Schedule

.1 Exterior Painting

.1 Primed Metal Surface:

Touch up with zinc chromate primer
Two (2) coats exterior alkyd semi-gloss enamel

.2 Galvanized coated metal surfaces:

One (1) coat zinc chromate primer
Two (2) coats exterior alkyd semi-gloss enamel

.3 Steel - Unprimed

One (1) coat zinc chromate primer
Two (2) coats alkyd enamel semi-gloss

.2 Interior Painting:

.1 Primed Metal Surfaces:

One (1) coat enamel undercoat
Two (2) coats alkyd semi-gloss enamel

.2 Galvanized Metal Surfaces:

One (1) coat galvanized iron primer
Two (2) coats alkyd semi-gloss

.3 Concrete Block and Concrete

One (1) coat latex block filler
Two (2) coats alkyd enamel semi-gloss finish

END OF SECTION

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DIVISION 10

Reviewed and Approved

Date

WASHROOM ACCESSORIES

1. GENERAL

1.1 Related Documents

.1 Drawings, General Conditions, and Division 1 General Requirements.

1.2 Section Includes

.1 Provide all labour, materials, methods, equipment, accessories to complete supply only of all washroom, bathroom equipment.

.1 Attachment, fastening devices, fasteners, etc.

1.3 Related Sections

.1 Rough Carpentry: Section 06105

1.4 Shop Drawings

.1 Submit list approved washroom equipment and, accessory items for Contract Administrator review prior to Subcontract award.

.2 Submit Shop Drawings, catalogue illustrations.

.3 Indicate size, description of components, base material, surface finish inside, outside, hardware, locks, attachment devices, description of rough-in frame, indicating fastening, installation.

1.5 Templates, Instructions

.1 Provide templates, mounting instructions for supporting devices, anchor plates, etc. built into wall, other surfaces.

1.6 Samples

.1 Submit samples each fixture, washroom equipment item specified, for Contract Administrator approval prior to ordering, prepaid to the Contract Administrator's office.

1.7 Maintenance Instruction Data

.1 Provide the City with typed, printed instructions for operating, cleaning, servicing, maintenance of washroom equipment, specialties.

.2 Provide Manufacturer’s Representative to instruct City personnel in operating techniques, equipment care as requested.

2. PRODUCTS

2.1 Materials

.1 Sheet steel: to American Society for Testing and Materials (ASTM) A526-80, commercial grade, stretcher leveled sheet steel, zinc coating class Z275, to ASTM A525-80.

.2 Stainless steel sheet: AA alloy 18/8 nickel chrome content, Type 304, No.4 brushed finish, 0.03125 inches thick.

.3 Stainless steel tubing: American Iron Steel Institute (AISI) Type 304, commercial grade, seamless welded, 0.051" minimum thickness.

.4 Aluminum: extruded, 6463-T5 alloy, polished, anodized to simulate No.4 stainless steel finish.

.5 Chrome, nickel plating: to ASTM B456-79, satin finish.

.6 Fastenings/accessories: screws, bolts hot dipped galvanized. Expansion shields fiber, leas, rubber, recommended by fixture Manufacturer for component, intended use. Provide templates, instructions, for supporting devices built into wall, other surface.

.7 Metal gauges: sufficient to withstand purpose washroom equipment item designed.

.8 Adhesive: epoxy type, contact cement.

2.2 Fixtures, Equipment

.1 Washroom accessories: Bobrick Washroom Equipment of Canada Ltd. Manufacturer.

.1 Soap Dispenser: B2112

.2 Toilet paper holder: B-667, recessed mounting, stainless steel.

.3 Paper towel dispenser, waste receptacle: B-36903, recessed mounting, stainless steel face, molded plastic waste container.

.4 Mirror: B-290, 6mm plate glass, stainless steel frame, size: 600W x 900H, required.

2.3 Keying Washroom Equipment

.1 Key alike towel cabinets.

2.4 Fabrication

.1 Fabricate washroom equipment items without exposed fastenings on exposed surfaces, welded construction.

.2 Grind joints, welds smooth, free of sharp edges, burrs. Fill open joints.

.3 Use mechanical fasteners only where approved.

.4 Form exposed surfaces from one (1) sheet of stock, free of joints, flat without distortion. Maintain flat surfaces without scratches, dents.

.5 Back paint components where item in contact with building finishes, to prevent electrolysis.

.6 Hot dipped galvanized fasteners metal anchors, fastening devices.

.7 Shop assemble components, packaged complete with anchor plates, fittings, etc.

.8 Provide templates, rough-in measurements, required.

3. EXECUTION

3.1 Preparation

.1 Obtain, make ready, prepare all materials, items. Cause no delays to scheduling.

.2 Verify and determine, to the Contract Administrator's approval, the exact locations of washroom equipment on job Site.

.3 Refer to Schedules, Detail Sheets, Drawings for location, types, equipment, item quantities.

.4 Verify, provide items, quantities indicated, required for proper, full use of area.

END OF SECTION

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DIVISION 11

Reviewed and Approved

Date

GENERAL PROCESS PROVISIONS

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational process systems to meet requirements described herein and in complete accord with applicable Codes and Ordinances.

.2 Contract Documents of this Division and Process Drawings are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow Manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown, close to building structure with minimum interference with other services or free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other contractors or by the City. Uncrate equipment, move in place and install complete; start-up and test.

1.2 Regulations

.1 All Work carried out under this Division shall be in full accordance with all applicable Codes, Regulations, By-laws and Ordinances and nothing in the plans and Specifications shall remove this responsibility.

1.3 Permits, Fees and Inspections

.1 Apply for all permits, supply all test certificates and pay all fees to authorities having jurisdiction regarding the installation and inspection of the complete process systems, installed under this Contract.

1.4 Existing Conditions and Other Trades

.1 Visit the Site to determine existing conditions affecting the Work of this Division. Failure to do so shall not remove the responsibility for the effects of such conditions on the Work.

.2 Examine the Mechanical, Structural, Electrical, and Controls and Instrumentation Drawings and become fully familiar with the Work of other trades under this Contract.

.3 Maintain the utmost co-operation with all other trades. Particular attention must be paid to the proximity of all electrical cables, control conduits, and utilities to the Work. Maintain maximum clear ceiling heights throughout. Provide connections of sizes as shown on the Drawings for connection by other trades.

1.5 Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified. Use same brand or Manufacturer for each specific application.

1.6 Scope of Work

.1 Refer to Section 01010 for the Scope of Work. The Work requires the supply and installation of such components as are necessary to construct complete functional and operational systems for all Sections of the Work.

.2 Consideration will not be granted for any alleged misunderstanding of the extent of the Work to be performed. Tendering a proposal shall convey full agreement to all items and conditions specified, indicated on the Drawings, and/or required by the nature of the Site.

1.7 Discrepancies and Omissions

.1 These Specifications shall be considered as an integral part of the Drawings, which accompany them, and neither the Drawings nor Specifications shall be used alone. Any items or subject omitted from one but which is mentioned and/or indicated in the other shall be considered as properly and sufficiently specified and shall therefore be provided.

.2 Should the Contractor find discrepancies or omissions in the Contract Documents, or be in doubt as to the intent thereof, he shall immediately obtain clarification from the Contract Administrator.

1.8 Transportation and Hoisting

.1 Assume responsibility for hoisting, warehousing, and demurrage for all equipment and materials to be furnished under other Supply Contracts.

.2 Assume responsibility for transportation, hoisting, warehousing, and demurrage for all equipment and materials to be furnished and installed under this Division.

1.9 Definitions and Interpretations

.1 Where the term "Provide" is used herein, it shall be understood to include labour, materials, and services necessary to supply, install and make functional the items or Work referenced.

.2 Where the term "Instructions" or "As Instructed" or "Where Instructed", etc. is used herein, it shall be understood to mean as instructed in writing by the Contract Administrator.

.3 Where the term "Listed" is used herein, it shall be understood to mean that the materials or equipment have been tested in accordance with applicable standards and methods, have been approved and listed for the intended use by a testing authority which itself has been approved by the authorities having jurisdiction.

.4 Where the term "Approved", "Approval", etc. is used herein, it shall be understood to mean approved by Authorities having jurisdiction as conforming to Codes, Standards, By-Laws, etc.

.5 Where the term "Acceptable" or "Acceptance", etc. is used herein, it shall be understood to mean acceptable to the Contract Administrator as conforming to the requirements of the Contract Documents.

.6 Where the term "Submit for Review" is used herein, it shall be understood to mean submit to the Contract Administrator.

.7 Where the term "Subject to Review" etc. is used herein, it shall be understood to mean Work shall be laid out for review by the Contract Administrator. No Work shall proceed until written instructions have been obtained from the Contract Administrator. Submit further information, Shop Drawings, samples, etc. as specified and/or as may be reasonably requested by the Contract Administrator.

.8 Where the term "Accessible" is used herein, it shall be understood to mean readily approachable by person or tools as required and where obstacles may be removed and replaced without cutting or breaking out materials.

.9 Where working pressure or pressure ratings are specified or shown on the Drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

1.10 Shop Drawings

.1 Refer to Section 01300 for the general requirements for Shop Drawings.

.2 For specific requirements for Shop Drawings for various pieces of equipment, refer to the relevant specific Sections describing the equipment.

.3 Shop Drawings shall be complete; capable of illustrating fully that the Product to be supplied is in accordance with the Specifications; including design considerations, materials, and accessories and spare parts. Include wiring diagrams for power supply and control schematics for all electrically powered and/or controlled equipment.

.4 Shop Drawings, which are not considered complete, will be returned to the Contractor "Not Reviewed" or "Rejected". It is the responsibility of the Contractor prior to submittal to ensure that they are in accordance with the requirements of the Specifications.

.5 Submit Shop Drawings in an expedient fashion in accordance with the Contract requirements and allowing sufficient time for review and implementation prior to Contract completion.

.6 Shop Drawings of equipment supplied under other Contracts will be made available to the Contractor to assist in the installation.

1.11 Coordination

.1 Coordinate with other Divisions the location of openings, housekeeping pads and anchor bolts.

.2 Coordinate the connection of the services of other Divisions to the equipment and material supplied under this Division.

.3 Coordinate the supply of equipment provided by other Supply Contracts with the supply and installation of materials provided under this Division.

1.12 Minor Changes

.1 Equipment and materials shall be located and arranged generally as shown on the Drawings. However, minor changes may be required to suit the precise requirements of the actual equipment or materials supplied, or to avoid conflict between services.

.2 Prior to the installation of the relevant equipment or materials, the Contractor shall advise the Contract Administrator of the requirement for any minor changes (including box-outs and coring) and shall undertake such minor changes as instructed by the Contract Administrator. Such changes shall be undertaken at no extra cost except where the connection or arrangement is modified in length, or alignment, or position, by more than one metre; or if the change involves the addition of more than two (2) fittings greater than 150 mm in diameter.

1.13 Housekeeping Pads

.1 Housekeeping pads are required for all pieces of equipment unless otherwise noted. Dimensions shown on the drawings are for guidance only. Housekeeping pads shall be at least 100 mm larger than the equipment base plate(s) and 100 to 200 mm deep, unless greater or lesser depths are required to support the equipment at the proper elevation. The final housekeeping pad dimensions shall be based on the dimensions of the actual equipment to be installed, and the Manufacturer's recommendations.

.2 The Contractor shall coordinate the location and installation of all the housekeeping pads, to be done by other Divisions.

1.14 Metric Conversion

.1 All units in this division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When CSA approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

EQUIVALENT NOMINAL DIAMETER OF PIPES

mm	Inches	mm	Inches	mm	Inches
3	1/8	65	2-1/2	375	15
6	1/4	75	3	450	18
10	3/8	100	4	500	20
15	1/2	125	5	600	24
20	3/4	150	6	750	30
25	1	200	8	900	36
30	1-1/4	250	10	1050	42
40	1-1/2	300	12	1200	48
50	2				

1.15 Cutting and Patching

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective Section.

1.16 Substantial and Total Performance

.1 Prior to Substantial Performance Inspection, provide complete list of items, which are deficient at the time of the substantial performance inspection.

.2 Perform the following items prior to Substantial Performance Inspection.

.1 Make systems capable of operation with alarm controls functional and automatic controls in operation generally, but not necessarily finally calibrated.

.2 Make necessary tests on equipment including those required by authorities. Obtain certificates of approval.

.3 Complete valve tagging and identify equipment. Paint equipment, piping and install escutcheons.

.4 Lubricate equipment as per Manufacturer's data.

.5 Mail warranty forms to Manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one (1) year.

.6 Submit Operating/Maintenance Manuals as per Section 01300.

.3 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance Inspection have been corrected and the following items completed prior to the Total Performance Inspection:

.1 Complete final calibration of controls.

.4 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until Substantial Performance is declared.

1.17 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Thoroughly clean both existing and new piping, ducts and equipment of dirt, cuttings and other foreign substances.

.4 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.18 Temporary Usage

.1 Usage by the City of any process device, apparatus, machinery or equipment prior to Total Performance being issued is not to be construed as acceptance.

1.19 Ductwork Cleaning

.1 Protect all existing supply, exhaust and return air openings with temporary filters (minimum 20% filters equal to Farr 20/20, 25 mm thick).

.2 At completion of project, remove all temporary filters and replace all existing air handling unit filters. At the Contract Administrator's discretion, turn the air handling unit filters over to the City, rather than installing in the units.

.3 If, in the Contract Administrator's opinion, the existing ductwork has been made dirty by completion of the project, vacuum duct systems as indicated by the Contract Administrator.

1.20 Painting and Identification

.1 Coordinate colour coding of piping and equipment with that of the existing plant. All piping and equipment is to be painted.

.2 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.3 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

1.21 Acceptable Products and Acceptable Manufacturers

.1 The first Product specified in a Product list is considered the "Design Standard" unless noted otherwise. The Design Standard is taken to mean that Product has been used as the basis for design. Dimensions, operating protocol, basic materials, etc. have been incorporated in the design.

.2 Where one or more Acceptable Products or Acceptable Manufacturers have been listed for an item of equipment, these are accepted as equivalent in concept to the Design Standard, if a Design Standard is listed. Incorporation of equipment options to satisfy the intent of the Specifications such that the process system would function as intended with the Design Standard is the responsibility of the Contractor. Modifications to the equipment services, supports, structure, etc., to suit acceptable Products shall be the responsibility of the Contractor.

.3 It remains the responsibility of the Contractor to ensure the Products supplied are equal to the specified Products in every respect, operate as intended, and meet the performance Specifications and physical dimensions of the specified Product.

.4 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable Manufacturers and suppliers' list.

.5 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the tender. If no Manufacturer's names are submitted, it will be assumed that the price carried in the tender was that of the specified Manufacturer or where the specified Product is generic, the first acceptable Manufacturer listed for each item and equipment.

1.22 Delivery Schedule

.1 The Contractor is to co-ordinate the equipment and material delivery schedule with the suppliers of the equipment and materials supplied under this Contract to suit the construction schedule. The dates for delivery shall be identified within twenty (20) working days of Contract award. These delivery dates may be altered by mutual agreement between the Contractor and the Contract Administrator.

1.23 Delivery

.1 The Contractor shall be responsible for unloading the equipment and materials supplied under this Contract and shall examine all packages on delivery, compare with the shipping list, and inform the supplier, the Contract Administrator and the carrier of any visible damages or defects. The Contractor shall arrange with the supplier to have the supplier replace any damaged or defective items.

1.24 Storage

.1 The Contractor shall provide temporary buildings and covered space for storage at the Site of all equipment prior to installation. The location of such building will be acceptable to the Contract Administrator and the City.

.2 Pipe and any other materials shall be stored in a manner, which prevents rust, deformation, weathering or any other physical deterioration. Covered space shall be provided by the Contractor if necessary to provide for this protection.

.3 The Contractor shall adhere to the Manufacturers' storage recommendations.

.4 Heated covered storage space shall be provided by the Contractor for sensitive items of equipment such as motors, pumps, as well as other equipment or supplies specified in this Division or other Divisions.

1.25 Spare Parts and Special Tools

.1 If spare parts or special tools are to be provided with any equipment specified, the specific parts or tools will be listed in the relevant Specification Section and are to be supplied with the equipment.

.2 Where the operation of the equipment for a period of two (2) years would require that some specific spare parts are likely to be required, but are not listed in the Specification, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified spare parts shall be identified.

.3 Where some specific special tools are required for the maintenance and/or operation of a specific item of equipment, but are not listed, the Contractor shall so inform the Contract Administrator. Costs, delivery periods, and any other information relevant to the procurement of the identified special tools shall be provided.

.4 This clause does not relieve the Contractor of the responsibility to provide, at no cost, any spare parts required during the warranty period to repair malfunctioning or failed equipment. At the end of the maintenance period, the spare parts inventory shall be replenished to allow for the above.

1.26 Tender Price Breakdown

.1 Submit a tender price breakdown within thirty (30) days of tender closing and before first progress claim, in a format required by the Contract Administrator.

1.27 Abbreviations

.1 The following abbreviations are found in the Process Specifications:

ABFMA	American Bearing Fabrication and Manufacturer Association
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BS	British Standard
CGSB	Canadian Government Standards Board
CSA	Canadian Standards Association.
DIN	Deutsche Industry Norm
MSS	Manufacturer's Standardization Society of the Valve and Fittings Industry

END OF SECTION

PROCESS EQUIPMENT INSTALLATION

1. GENERAL

1.1 Description

.1 Installation, including the supply of anchor bolts, and testing of equipment supplied by others and supplied under other Sections in Division 11.

1.2 Definitions and Interpretations

.1 Testing: In this Division, testing is defined as the operation of a specific item of equipment under actual and/or simulated conditions for the purpose of ensuring the equipment satisfies its basic design criteria. Testing shall be conducted by the Contractor. All materials, labour, power and equipment required to conduct the tests shall be the Contractor's responsibility. The Manufacturer is to provide technical assistance to the Contractor for the installation, testing, start-up and commissioning of the equipment supplied. Refer to Section 01650.

.2 Commissioning: In this Division, Commissioning is defined as the operation of equipment systems under actual and/or simulated conditions for the purpose of ensuring the system performs its intended functions. Refer to Section 01670.

1.3 Submissions

.1 Check all the Shop Drawings relative to the equipment and materials, dimensions, measurements, size of members, type of materials, controls, list of equipment being supplied, names of Manufacturers, and other details to affirm that they are correct and conform to the requirements and intent of the Contract.

.2 Where the Shop Drawings are submitted with coordination information missing, such as dimensions of structures, the Contract Administrator will return the submission as soon as practicable marked "Revise & Resubmit."

2. PRODUCTS

2.1 Equipment Schedule

.1 Unless indicated otherwise, supply and install all equipment listed on the Equipment Schedule, detailed on the equipment Specification sheets, or shown on the Drawings.

.2 Determine the extent of equipment to be supplied from the Specifications, list of equipment and materials and Manufacturer's Drawings covering the equipment. Furnish and install all additional materials necessary to complete the installation.

.3 Incorporate all ancillary devices in the installation including those providing for cooling water, seal water, lubricant supply, process drains, electrical connection, and instrumentation and control requirements.

2.2 Mounting Requirements

.1 Provide all supports, anchorage, and mounting of all equipment in accordance with the Manufacturer's recommendations, the National Building Code (NBC), and industry standard requirements, unless otherwise specified.

.2 Design and provide all elements required to resist the calculated forces described herein or required by the element Manufacturer.

.3 Design anchorage for all equipment bases, supports, and foundations in accordance with NBC for Seismic Zone 0.

.4 For rotating equipment, where specified, submit design notes and calculations for anchorage, signed and sealed by a Professional Engineer.

3. EXECUTION

3.1 Coordination

.1 Coordinate the Work specified under this Section with the Work of other Sections to produce a complete and workmanlike job.

.2 Coordinate the placement of equipment bases and housekeeping pads with Division 3.

.3 Coordinate the routing of ancillary piping with Division 15.

.4 Coordinate the routing of electrical and control wiring and conduit with Division 16.

3.2 Preparation

.1 Before commencing installation of the Work, inspect and take field measurements and ensure that Work conducted previously in the area is not prejudicial to the proper installation of the Works.

.2 Refer to the equipment Specifications and Specification sheets for assistance in determining the form in which equipment is to be shipped and the extent of field assembly required.

.3 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate and must be corrected by the Contractor to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.4 Schedule Manufacturer's Representative Site visits. Cooperate in his supervision of the installation and start-up. Follow all reasonable instructions of the Manufacturer's Representative. Should the Contractor require the Manufacturer's Representative to attend for longer or more frequent periods he shall arrange this, at his own expense, with the Manufacturer.

3.3 Installation of Equipment

.1 Install all equipment specified in other Sections, detailed on the equipment Specification sheets, or shown on the Drawings.

.2 Dimensions shown on the Contract Documents for equipment bases, piping connections, etc., are approximate. Correct to suit the exact dimensions of the equipment provided for each application. Arrange any necessary modifications to piping connections, pipework, or other ancillaries at no cost and after acceptance by the Contract Administrator.

.3 Supply and install all necessary shims, gaskets, etc., required to complete the installation.

.4 Provide for the use of all necessary lifting and loading equipment and all tools required to complete the installation.

.5 Comply with the specific requirements for installation noted in other Sections of this Specification and with the instructions of the Manufacturer. Where there is a conflict in these requirements, identify the conflict to the Contract Administrator and proceed as directed.

3.4 Equipment Bases and Anchorage

.1 Equipment will be mounted on housekeeping pads that are a minimum of 100 to 200 mm high.

.2 For rotating equipment of 7.5 kW or above and for equipment requiring structural anchoring, set anchor bolts in advance. Where required, set anchor bolts in sleeves to permit minor adjustment during installation. Use machine base templates where shown.

.3 Prepare grout as specified in Division 3 and provide full contact with the equipment bases unless otherwise recommended by the equipment Manufacturer and accepted by the Contract Administrator. Neatly bevel, form or trim the grout.

.4 Where equipment is supplied with a plate steel base, provide access holes in the top of the plate and use a pour grade, non-shrink, non-metallic grout as specified in the structural concrete Specifications to fill the entire void under the base.

.5 Fixings to concrete structures shall be by adhesive anchors suitably designed for the application.

3.5 Alignment

.1 Set and align all rotating equipment in accordance with the more stringent requirements of either the Manufacturer's requirements or the following:

.1 Level base, use machinists level on all machined bases.

.2 Align couplings to satisfy the following criteria:

Coupling Speed	Allowable Angular Misalignment	Allowable Parallel Misalignment
Under 100 rpm, below 50 hp	4'00"	0.25 mm
Under 100 rpm, 50 hp and over	3'00"	0.12 mm
100 to 600 rpm	2'00"	0.12 mm
600 to 1800 rpm	1'00"	0.10 mm
1800 to 3600 rpm	0'35"	0.05 mm

.3 Check for soft foot, maximum permissible 0.002 mm.

.2 Where equipment undergoes a substantial differential temperature rise (30°C between driver and driven unit), provide precision benchmarks in foundation and on equipment and perform alignment at operating temperatures.

.3 Demonstrate to the City of Winnipeg (City), Contract Administrator, and Manufacturer's Representative the final alignment.

3.6 Lubricants

.1 Extend any inaccessible lubrication points and lubricant drains to convenient locations.

.2 Remove storage lubricant and provide the initial fill of new lubricants for the equipment. Lubricant grade to be as recommended by the Manufacturer.

3.7 Vibration Survey

.1 Conduct a vibration survey under normal operating conditions for all equipment with a motor size exceeding 37 kW and for smaller units where specified.

.2 Use a calibrated vibration sensor, accepted by the Contract Administrator, and capable of measuring unfiltered vibration velocities and peak-to-peak amplitudes. Select a sensor capable of measuring velocities at a precision of 0.1 mm/s and an accuracy of plus or minus 0.2 mm/s.

.3 Monitor vibration in all three (3) dimensions at the head and tail end of both the driver and driven units, at intermediate bearing points, and at other critical locations which may be identified by the Contract Administrator.

.4 Record the vibration velocities for each item of rotating equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which vibration monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 Unless specified otherwise, use unfiltered velocities as the vibration criteria. Unfiltered velocities less than 5 mm/sec shall be considered acceptable. Undertake corrective action where unfiltered velocities exceed 5 mm/sec.

3.8 Noise Survey

.1 Conduct a noise survey for all equipment over 37 kW and for smaller units where specified.

.2 Use a calibrated noise meter, accepted by the Contract Administrator, and capable of measuring noise in the A Scale at a precision of 0.5 dBA and an accuracy of 1.0 dBA.

.3 Measure noise levels at an elevation similar to the major noise emitter from the equipment (bearing housing, muffler, etc.) and at a horizontal distance of 1.0 metres.

.4 Record the noise levels for each item of equipment and submit a report to the Contract Administrator detailing the findings. Include a description of the measuring equipment, identification of equipment on which noise level monitoring was completed, description of conditions under which the test was conducted, and a listing of all of the collected data.

.5 The general requirement for any item of equipment shall be that it operates at a noise level less than 85 dBA, when measured in free field at 1.0 metre. Noise requirements may be more stringent in areas where more than one (1) item of process equipment is intended to operate concurrently. Specific requirements for equipment that differ from 85 dBA are listed in the Sections related to those items of equipment.

.6 Noise abatement features (acoustic panels, acoustic insulation, etc.) are specified in other Sections.

.7 In any process area, recommend whatever measures necessary to maintain a composite noise level below 90 dBA. Where directed by the Contract Administrator, undertake those corrective actions.

3.9 Quality Assurance Forms

.1 Test all process equipment to ensure the equipment operates in accordance with the basic design criteria listed in the Specification Sections or equipment Specification sheets. Complete the series of forms that attest to the proper installation and functioning of the equipment. Refer to Section 01650 for the Forms.

END OF SECTION

DOCUMENTATION

1. GENERAL

1.1 Scope

.1 Operating and Maintenance (O&M) Manuals.

.2 Record Drawings.

1.2 Quality Assurance

.1 Work specified in this Section shall be performed by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

2.2 Record Drawings

.1 Refer to Division 1.

.2 The Contractor shall keep on-site, available to the Contract Administrator at all times and particularly for each regularly scheduled Site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of Drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.3 Provide Record Drawings, which identify location of piping, valves, fittings and equipment. As well, deviations that are to be recorded shall include in general, items that are significant or are hidden from view and items of major importance to future O&M, and to future alterations and additions including cleanouts and isolation valves.

3. EXECUTION

3.1 General

.1 Submit documents to the Contract Administrator for approval prior to transmitting to the City of Winnipeg (City).

3.2 Record Drawings

.1 Return marked up Drawings to the Contract Administrator, with the Contractors signature and a notation that the Drawings are accurate, reflecting any changes made to mechanical or other Divisions that are indicated on the mechanical Drawings.

DOCUMENTATION

END OF SECTION

SYSTEM DEMONSTRATION AND CITY'S INSTRUCTIONS

1. GENERAL

1.1 Scope

.1 Demonstration of equipment and systems operations.

.2 Instruction seminars for City of Winnipeg's personnel.

.3 Coordination of training program by ultraviolet (UV) Supplier for the UV system.

.4 Coordination of training program by UV influent pump and variable frequency drive (VFD) Suppliers for the pumping system.

1.2 Quality Assurance

.1 Work specified shall be performed by the Contractor.

2. PRODUCTS

Not applicable.

3. EXECUTION

3.1 General

.1 Contractor shall arrange for presentation and demonstration of electrical, mechanical and process equipment and systems by appropriate specialists and shall ensure that required Manufacturer's Representatives are in attendance.

3.2 Demonstrations

.1 Demonstrate specific starting and general maintenance requirements for each major piece of equipment. Ensure all labelling and identification is completed.

.2 Demonstrate the following systems, in the form of instruction seminars and contractor-guided tour of the facility.

.1 Mechanical Systems

.2 Electrical Systems

.3 UV Reactors and Related Equipment

.4 Pumps and Related Equipment

For mechanical systems, the Contractor shall include for three (3) separate half-day training sessions to demonstrate the systems to City staff. The Contractor shall provide his own staff and representatives of the equipment Suppliers to conduct the training. The Contractor shall

provide a training plan to the Contract Administrator for approval, and shall coordinate the training sessions with the Contract Administrator.

For UV systems, the Contractor shall coordinate the activities of the UV Supply Contractor's training programs. The UV Supplier's obligations for training may be viewed at the office of the Contract Administrator.

For UV influent pumping system, the Contractor shall coordinate the activities of the pump Supply Contractor's training program. The pump Supply Contractor's obligations for training may be viewed at the office of the Contract Administrator.

.3 Answer all questions raised by the City at demonstrations; if unable to satisfactorily answer questions immediately, provide written response within three (3) days.

END OF SECTION

COMMISSIONING

1. GENERAL

1.1 General

.1 For General Commissioning procedures and activities, refer to Division 1.

.2 The Commissioning process shall be applied to all Products, equipment and systems provided under this Division.

.3 Work specified in this Section shall be performed by the Contractor.

2. THE COMMISSIONING PROCESS

2.1 The Commissioning Team

.1 The Commissioning Team shall be formed and consist of:

.1 The Commissioning Agent, as provided by the Contractor.

.2 The Contract Administrator's representative.

.3 The City of Winnipeg's (City) Staff Representative.

.4 Manufacturers' and Suppliers' Representatives as required by the Contractor.

2.2 Duties of the Team

.1 The duties of the team are summarized below:

.1 The Commissioning Agent shall plan, organize and implement the Commissioning process and shall within one (1) month of the award of the Contract submit the name and address of the Commissioning Agent.

.2 The Commissioning Agent shall provide a complete description of the systems operation, performance and flow data to the Contract Administrator for review.

.3 The Commissioning Agent shall prepare the Commissioning Plan and provide demonstration and instructions to the City's staff over a period of time to enable the staff to become familiar with the systems.

2.3 Commissioning Schedule

.1 Within one (1) month of commencing with the project Work the Commissioning Agent shall review design intent and intended Commissioning procedures with the Contract Administrator. At least ninety (90) days prior to the planned start of Commissioning, submit a detailed plan identifying the orderly progression of the prestart Commissioning Check and subsequent Commissioning Performance Check of each sub-system, leading up to the ultimate Commissioning of entire systems.

.2 Submit a schedule for the Commissioning phase of the Work. This schedule shall show:

.1 Completion dates for each trade in each major section of the building.

.2 Timing of the various phases of the Commissioning, testing, and demonstration process.

.3 Submission dates for the various documents required prior to verification of Commissioning by the Contract Administrator.

.4 Prepare a Commissioning statement addressing each of the five (5) phases that the process is perceived to be. In sequence, the phases are expected to be:

Phase 1 - System Readiness
Phase 2 - System Start-Up, Testing, Commissioning
Phase 3 - Verification of System Commissioning
Phase 4 - Validation
Phase 5 - Demonstration and Acceptance

.3 With the Commissioning Schedule noted above, submit a copy of all Commissioning worksheets to be used during the Commissioning process.

.4 Each phase except Phase 4 is applicable to each major and separate system making up the Work in Division 11, Division 15 including controls, and Division 16 interface as applicable.

2.4 Commissioning Phases

.1 **Phase 1** - Before starting any of the separate systems, provide written verification stating that the specific system is ready for start-up and the following conditions have been met:

.1 Copies of all test and certificates have been submitted to the Contract Administrator.

.2 All safety controls installed and fully operational (dry run test).

.3 Flushing, chemical cleaning (as required), charging, fluid operating (as required), are complete.

.4 Equipment lubrication and pre-start checks are complete.

.5 Control functional checks, including all alarms performed.

.6 Start-up verification checks by Manufacturers Representatives completed.

.7 All deficiencies to be recorded reviewed by the Commissioning Team and, subsequently corrected before proceeding to the next phase, Phase 2.

.2 **Phase 2** - System Commissioning shall include but not necessarily be limited to:

.1 Activation of all systems.

.2 Testing and adjustment of all systems.

.3 As in the case of the System Readiness Phase, all deficiencies are to be recorded, reviewed by the Commissioning Team and, subsequently, corrected. The process at the point of the deficiency shall be repeated before proceeding forward.

.4 Phase 2 is concluded when the installation is in full working order and acceptable for use. The Work will include setting up the following:

.1 All flow measurement devices

.2 Manual valves

.3 Gate actuators

.4 UV reactors

.5 Pumps

.5 Fine Tuning:

.1 Setting up equipment for accurate response and precise sequencing.

.6 Testing:

.1 The Commissioning Agent shall perform a detailed check of the following:

.1 All items and functions to be later demonstrated to the City's Representatives.

.3 **Phase 3** - Verification of Commissioning.

.1 Verification of Commissioning by the Contract Administrator shall not commence until the Commissioning process, Phase 2, has been totally completed. Submit test procedure completion test certificates at the time of requesting the commencement of the verification procedure. The verification process will include the demonstration of the following:

.1 Operation of all equipment and systems, under each mode of operation.

.2 At the completion of Phase 3, the Contractor shall submit the following to the Contract Administrator:

.1 A letter certifying that all Work specified under this Contract is complete, clean and operational in accordance with the Specification and Drawings.

.2 A copy of Phase 2 Verification Certificates provided by the specialist trades for submission to the Contract Administrator.

.3 Record Drawings as specified.

.3 Upon receipt of all documents and a satisfactory outcome of the verification procedure, the Contract Administrator will provide a Certificate of Verification for Phase 3.

.4 Substantial Performance may, thereupon, be declared.

.4 **Phase 4** - Validation. Participate in validation in accordance with Section 01010 and the approved Validation Protocol.

.5 **Phase 5** - Demonstration and Acceptance shall not commence until the Commissioning process Phase 3 has been successfully completed - verification certificate issued and Substantial Performance declared. The demonstration process is a statement of satisfaction from the Contract Administrator upon completion. Total Performance will not be accomplished without this achievement.

3. EXECUTION

.1 The following systems are to be commissioned:

.1 Pumps

.2 UV system

.3 Gates and actuators

.4 Flow measurement meters

.5 Piping System - pressure tests, insulation, identification, water balance, hangers, and expansion.

.6 Mechanical Systems

.7 Electrical Systems

END OF SECTION

DETAILED PIPING SPECIFICATION SHEETS

1. GENERAL

1.1 Work Included

.1 The piping Specification sheets on the following pages detail the requirements for each type of pipe included in the Work.

.2 The piping materials are listed on the Specification sheets.

2. PRODUCTS

2.1 Commodity Summary

Table 1: Process Fluids and Pipe Materials

Abbreviation	Process Commodity	Pipe Material
SE	Secondary Effluent	Mild Steel, CW or ERW

2.2 Schedule

.1 See following pages

DETAILED PIPING SPECIFICATION SHEETS

SE

GENERAL					
PROCESS FLUID	SYMBOL	MAXIMUM CONDITIONS		TEST CONDITIONS	
		PRESSURE (kPa)	TEMP. (°C)	PRESSURE (kPa)	DURATION (Min.)
Secondary Effluent	**SE**	50	30	100	120

PIPE					
LOCATION	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Underground	≥100	Mild Steel, CW or ERW	Std. Wt.	ASTM A53, Grade B	
Below Structures	≥100	Mild Steel, CW or ERW	Std. Wt.	ASTM A53, Grade B	
Submerged	≥100	Mild Steel, CW or ERW	Std. Wt.	ASTM A53, Grade B	

COATINGS				
LOCATION	SIZE (mm)	MATERIAL	SPECIFICATIONS	REMARKS
Underground	≥100	Yellow Jacket		
Tunnels, Pumphouses and Buildings	>75	Paint		
Below Structures	≥100	Concrete Encased		
Submerged	≥100	Coal Tar Epoxy	AWWA C210	

LININGS				
LOCATION	SIZE (mm)	MATERIAL	SPECIFICATIONS	REMARKS
Underground	≥100	Coal Tar Epoxy	AWWA C210	
Tunnels, Pumphouses and Buildings	>75	Coal Tar Epoxy	AWWA C210	
Below Structures	≥100	Coal Tar Epoxy	AWWA C210	
Submerged	≥100	Coal Tar Epoxy	AWWA C210	

JOINTS					
LOCATION	SIZE (mm)	TYPE	MAXIMUM SPACING	SPECIFICATIONS	REMARKS
Underground	≥100	Butt Weld	N/A		
Below Structures	≥100	Butt Weld	N/A		
Submerged	≥100	Butt Weld Grooved Joint	N/A 20 m	AWWA C606	

FITTINGS AND APPURTENANCES					
ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Flanges, FF or RF	≥100	Mild Steel	Class 150	Material: ASTM A181, Gr.1 Dimensions: ANSI B16.5	
ELL - Short Radius ELL - Long Radius, Tees, Reducers, Reducing Outlets, Laterals	≥100	Mild Steel, Seamless	Same as Pipe	Material: ASTM A181, WPB Dimensions: ANSI B16.5 ANSI B16.9	
Plug	≥100	Mild Steel	Class 150 Blind Flange	Material: ASTM A181, Gr.1 Dimensions: ANSI B16.5	
Sockolet					
Threadolet					
Flanged Adaptors	≥100	Same as Pipe	Same as Pipe	Flange: ANSI B16.5	

DETAILED PIPING SPECIFICATION SHEETS

SE (continued)

FITTINGS AND APPURTENANCES (continued)					
ITEM	SIZE (mm)	MATERIAL	RATING	SPECIFICATIONS	REMARKS
Expansion Couplings					
Flanged Gaskets	100 - 250 300 - 450 ≥500	Bl. Neoprene Bl. Neoprene Bl. Neoprene	1.6 mm thick 3.2 mm thick 6.4 mm thick		
Grooved Joint Gaskets	≥100			AWWA C606	
VALVES					
TYPE	SIZE (mm)	VALVE SPECIFICATION (SECTION 15105)			REMARKS
Butterfly	≥75	BF02			
Ball	<75 ≥75	BV02 BV03			
Check	≥75	CV02			
Globe	N/A	-			
Gate	N/A	-			
Mud	≥75	MV01			
Needle	<75	NV01			
NOTES					

END OF SECTION

VALVE AND GATE ACTUATORS

1. GENERAL

1.1 Work Included

.1 Supply, delivery, and supervision of installation, and testing of process electric and pneumatic actuators.

1.2 Submissions

.1 Shop Drawings: Submit Shop Drawings for all actuators in accordance with Section 01300 and Section 11005. In addition to the information requirements of Section 11005, include the following:

.1 Calculations indicating the operating torque of the valve or gate for which the actuator is to be supplied.

.2 The torque rating of the actuator.

.2 Operating and Maintenance Data: Provide for incorporation in operation and maintenance (O&M) manual as specified in Section 01735.

1.3 Delivery and Storage

.1 Deliver actuators to Site using unloading methods which do not damage casings or coatings.

.2 Clearly tag actuators indicating size, type, model number, coatings, and mating parts.

.3 Store on-site for incorporation in the Work using methods recommended by the Manufacturer to prevent damage, undue stresses, or weathering.

1.4 Process Valve and Actuator Detailed Specification Sheets and Schedules

.1 Process Valves are identified in the Drawings by an alpha-numeric code.

.2 Create a valve schedule listing the critical valves required for process operation. The schedule lists the valves and actuators by type, and the function and location of the valve in the process. Ensure all valves and actuators are in compliance with the Section 15100. Do not commence Work on any piping runs until review of valve and actuator selection has been received from the Contract Administrator.

2. PRODUCTS

2.1 General

.1 Provide new, unused actuators for the Work.

.2 Use materials for actuators that are free from defects or flaws.

.3 Tag actuators to indicate operating characteristics and inlet and outlet ports for electric or pneumatic services.

.4 Standard of acceptance for all on/off electric actuators shall be Rotork.

.5 Provide actuators with mechanical position indicators

2.2 Drawings

.1 Review and verify Piping and Instrumentation Drawings (P&IDs), ensuring that they indicate all valves and automatic actuators that are critical to proper process operation. Where valves or actuators are not indicated, inform Contract Administrator.

2.3 Manual Actuators

.1 Provide valves with manual actuators unless indicated otherwise in other Specification Sections or shown on the process and instrumentation Drawings.

.2 For manual actuators located more than 1,830 mm above the floor, provide chain operators.

2.4 Electric Actuators, Open/Close, Quarter Turn, Less than 1,000 N-m Torque

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for on/off service.

.2 For actuators rated at less than or equal to 100 Nm, incorporate a 120V/1 phase/60 Hz motor. For actuators rated at greater than 500 Nm and less than or equal to 1,000 Nm, use a 208 V/3 phase/60 Hz motor. In each case, use motors that are high torque, reversible.

.3 Use motors that are rated for continuous duty, as defined in the appropriate National Electrical Manufacturers Association (NEMA) standard.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Make each actuator capable of operating in any horizontal or vertical orientation.

.8 Provide external mechanical indication of valve position.

.9 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.10 For actuator drive train, use steel or aluminum gears arranged with worm gears or compound gear assembly. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an Anti-Friction Bearings Manufacturers Association (AFBMA) B10 life in excess of 40,000 hours.

.11 Use gears and bearings that are non-lubricated or permanently lubricated.

.12 In each actuator, incorporate two (2) Single Pole, Double Throw (SPDT) travel limit switches, 10A, 120V AC, Canadian Standards Association (CSA) listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two (2) SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.5 Electric Actuators, Open/Close, Quarter Turn, Greater or Equal to 1,000 kN-m Torque

.1 Use electric operators that are suitable for mounting on quarter turn valves intended for open/close service.

.2 Incorporate a 600V/3 phase/60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least ten (10) starts per hour. Size motor to open valve within 60 seconds maximum.

.3 Use motors that are rated for continuous duty, as defined in International Electrotechnical Commission (IEC) Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with American Gear Manufacturers Association (AGMA) standards for heavy duty, intermittent service. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an AFBMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two (2) filling points.

.11 In each actuator, incorporate two SPDT travel limit switches, 10A, 120V AC, CSA listed. The travel limit switches shall each be adjustable.

.12 In each actuator, incorporate two SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.13 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.14 Protect exterior mounted actuators against high temperature and condensation.

.15 Design the actuator so that the opening and closing speed is field adjustable.

.16 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.6 Electric Actuators, Open/Close, Multi-Turn

.1 Use electric operators that are suitable for mounting on non-rising stem valves or gates that are intended for open/close service.

.2 Incorporate a 600V/3 phase/60 Hz motor. Use motors that are high torque, reversible. Select motor that is capable of at least ten (10) starts per hour. Size motor to provide a minimum of 30 rpm or sufficiently high to open or close gate within ten (10) minutes, whichever requires greater motor size.

.3 Use motors that are rated for continuous duty, as defined in IEC Standard 34-1.

.4 Incorporate thermal overload devices in motor windings to protect the motor against overheating.

.5 Unless noted otherwise, design the actuators to fail to the last position when the control function or power fails.

.6 Fit each actuator with a hand wheel that will enable manual override control of the valve or gate. Incorporate a method of ensuring that when the manual override is engaged, motor driven operation is precluded.

.7 Provide external mechanical indication of valve or gate position.

.8 House internal components in a NEMA 4X enclosure, waterproof and moisture resistant and corrosion-resistant, and permanently lubricated. Use stainless steel connectors for all exposed connections.

.9 For actuator drive train, use stainless steel or machine steel gears and shafts. Design gears in accordance with AGMA standards for heavy duty, intermittent service. Provide method that allows higher shock loads to valves or gates at the beginning of operation so that they unseat. Ensure that geared drive train can withstand locked rotor conditions. Incorporate bearings designed with an AFBMA B10 life in excess of 40,000 hours.

.10 Use oil lubricated gearbox. Seal using o-rings or gaskets. Provide a minimum of two (2) filling points.

.11 Design so that motor can be disconnected without draining the lubricant from the actuator gear case.

.12 In each actuator, incorporate two (2) SPDT travel limit switches, 10A, 120V AC, CSA listed. The travel limit switches shall each be adjustable.

.13 In each actuator, incorporate two (2) SPDT torque limit switches, 10A, 120V AC. Make the torque limit switches factory pre-set and field adjustable.

.14 Provide mechanical limit stops, adjustable, to ensure over-turning of the valve door does not occur.

.15 Protect exterior mounted actuators against high temperature and condensation.

.16 Design the actuator so that the opening and closing speed is field adjustable.

.17 Provide a terminal board for field wiring. Include contacts to indicate the open/closed status of the valve, overheating alarm, and overtorque alarms.

2.7 Electric Actuators, Modulating

.1 Provide operators to be suitable for mounting on sliding-stem valves and gates requiring linear actuation, and intended for modulating service.

.2 Select actuators that modulate in response to a 4-20 mA control signal. Incorporate a servo drive system suitable for continuous modulation.

.3 For modulating service, select motors that are capable of 1,200 starts per hour.

.4 Fit actuators for modulating duty with a position retransmit module (4-20 mA) for remote indication.

2.8 Current-to-Pneumatic (I/P) Converters

.1 Provide I/P converters where required.

.2 Supply all required hardware for mounting the I/P converter on the controlled device.

.3 I/P converter to be of Electrical & Electronic Manufacturers Association of Canada (EEMAC) 4, minimum.

.4 I/P converter to operate with instrument quality control air at an operating pressure range of 20 to 200 kPa.

2.9 Valve Positioners

.1 When specified on the instrument specification sheets supply compatible positioners pre-mounted to each actuator. Do not mount 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 (3) 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.

2.10 Position Switches and Indicators

.1 When specified on the Instrument Specification Sheets, supply actuator assemblies pre-mounted with external position monitors which include two (2) cam actuated "GO" Form C rated proximity switches, a 5-pole male receptacle, a polycarbonate dome beacon and an EEMAC 4 (minimum) 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 in the closed position, and green in the open position.

.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.

2.11 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 isolation valve.

.2 Mount loading station on a galvanized plate attached to a floor stand. Locate station within 2 m of the controlled device.

2.12 Finishes

.1 Actuators shall be shop finished in accordance with Section 11901.

3. EXECUTION

3.1 Preparation

.1 Prior to the installation of the actuators, field measure and check all equipment locations, pipe alignments, and structural installations. Ensure that the valve location and orientation provides suitable access to manual actuators and that sufficient space and accessibility is available for maintenance and to allow unobstructed view of operation and position of pneumatic and electric actuators.

.2 Where conflicts are identified, inform the Contract Administrator and initiate the necessary piping modifications.

3.2 Installation Training

.1 Inform the installer of all procedures and requirements necessary for the successful installation of the equipment. Attest to the installer's understanding by completing Form 101 as shown in Section 01650.

3.3 Installation

.1 Ensure the equipment is installed as required to provide satisfactory service.

.2 Cooperate with the installer to fulfill the requirements for a successful installation, as documented by Form 102, illustrated in Section 01650.

3.4 Testing

.1 Ensure the equipment, including all component parts, operates as intended. Testing includes field verification of operating speed and torque outputs at rated operating conditions.

.2 Cooperate with the installer to fulfill the requirements for successful testing of the equipment as documented by Form 103, illustrated in Section 01650.

3.5 Commissioning

.1 Attend during Commissioning of the process system which includes the equipment specified in this section and to ensure the equipment functions as intended in the process system.

END OF SECTION

FLAP GATES

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation and Commissioning of flap gates.

1.2 Submittals

.1 Shop Drawings: Submit in accordance with Section 01300 and Section 11005.

.2 For each type of gate, provide:

.1 Frame assembly details.

.2 Concrete embedment and attachment details.

.3 Installation instructions.

.4 Seal Details.

.3 Operating and Maintenance Data: Provide for incorporation in operation and maintenance (O&M) manual as specified in Division 1.

.4 Design calculations and supporting data for all gates showing stresses, loads and deflection for critical parts under design head conditions.

2. PRODUCTS

2.1 General

.1 Square flap gates – stainless steel

.2 Shop assemble and inspect gates to ensure that field fitting will not be required.

2.2 Acceptable Manufacturers

.1 Fontaine

.2 Armtec

.3 Rodney Hunt

.4 Whipps

2.3 Leakage

.1 Do not exceed 0.025 L/s per metre of wetted perimeter under the maximum seating and unseating pressure.

2.4 Materials and Construction

.1 Flap gates shall be constructed entirely of stainless steel, with stainless steel hardware.

.2 The flap gate body shall be made of structural members or formed plate welded to form a rigid one-piece frame. The frame shall be of the integral flange back design suitable for mounting on a concrete wall (CW).

.3 The gate cover shall be made of structural members or formed plate adequately reinforced to withstand the maximum specified seating head without distortion.

.4 Seals shall be made of EPDM attached to the body by means of a flat stainless steel strip bolted to the frame.

.5 The hinges shall consist of a stainless steel pin and shall have an ultra high molecular weight polyethylene (UHMWPE) bushing.

.6 Hinge arms shall be made of structural members or formed plates. On flaps 762 mm and over, hinge-arm arrangement shall have two (2) pivot joints per arm, an adjustable lower pivot with limited rotation and an adjustable upper hinge lug arrangement to permit adjustment of the gate opening sensitivity to unseating head.

2.5 Materials

Part	Material
Body, cover, hinges, hinge arm	Stainless steel ASTM A-240, Type 304L or 316L
Hinge bushing	Ultra high molecular weight polyethylene (UHMWPE), ASTM D-4020-96
Seal	EPDM ASTM D-2000
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer’s Representative shall be required to attend the Site to train installation personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation

.1 Coordinate blockouts or cast in place items.

.2 Install gates with square corners, in a vertical plane, with tolerances within Manufacturer's recommendations.

.3 Install gate operators as per Manufacturer’s recommendations. Align to ensure there is no distortion of stems or moving parts.

3.3 Testing

.1 Test each gate for leakage by filling the channel on one (1) side of the gate and measuring leakage through the gate. Undertake the test after twenty-four (24) hours to allow for the concrete to absorb water.

3.4 Commissioning

.1 Arrange Manufacturers Representative attendance during Commissioning of the process system which includes the gates specified in this Section to ensure that each gate functions as intended in the process system.

END OF SECTION

STOPLOGS

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation and Commissioning of open channel flow control stoplogs.

1.2 Submittals

.1 Shop Drawings: Submit in accordance with Section 01300 and Section 11005.

.2 For each type of gate, provide:

.1 Frame assembly details.

.2 Concrete embedment and attachment details.

.3 Installation instructions.

.3 For each stoplog, provide:

.1 Seal Details.

.4 Operating and Maintenance Data: Provide for incorporation in operation and maintenance (O&M) manual as specified in Section 01735.

.5 Design calculations and supporting data for all gates showing stresses, loads and deflection for critical parts under design head conditions.

2. PRODUCTS

2.1 General

.1 Shop assemble and inspect stoplogs to ensure that field fitting will not be required.

2.2 Acceptable Manufacturers

.1 Fontaine

.2 Armtec

.3 Rodney Hunt

.4 Whipps

2.3 Stop Log Frames

.1 Design the frames to be mounted in a concrete channel.

.2 Extend grooves in the frames to walkway level.

.3 Provide frames of stainless steel type 304, with integral concrete anchors.

.4 Minimum width and thickness of frames shall be 114 mm and 6.35 mm, respectively.

2.4 Stop Logs

.1 Provide stop logs of stainless steel type 304, minimum 6.35 mm thickness and designed to limit deflection to 1/360 of span.

.2 Provide lifting lugs or holes near the end of each log. Recess mating logs to accommodate the lifting lugs.

.3 Provide drainage in each stop log to prevent buoyancy and water retention.

.4 Make downstream welds continuous.

.5 Provide wall mountable frame(s), compatible with concrete block walls, on which up to five (5) stop logs can be stored while out of the channel(s).

2.5 Guides and Seals

.1 Provide guides of ultra high molecular weight polyethylene (UHMWPE) with neoprene rubber J seals with Teflon facing and of sufficient length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the full open position.

.2 The seals shall maintain the specified leakage rate in both seating and unseating conditions.

.3 Provide resilient neoprene bottom seal set into the bottom member of the frame to form a flush bottom.

.4 Provide the stop logs with J-bulb or urethane seals along the sides and a neoprene bottom seal. Provide an uninterrupted seal at the face of the stop log groove and at the joint with the adjacent log. The bottom stop log seals flush with the invert of the channel.

2.6 Leakage

.1 Do not exceed 0.025 L/s per metre of wetted perimeter under the maximum seating and unseating pressure.

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer's Representative shall be required to attend the Site to train installation personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation

.1 Coordinate blockouts or cast in place items.

3.3 Testing

.1 Operate each gate with and without liquid to show that each can be operated.

.2 Test each stoplog installation for leakage by filling the channel on one side of the stoplog and measuring leakage through the stoplog. Undertake the test after twenty-four (24) hours to allow for the concrete to absorb water.

3.4 Commissioning

.1 Arrange Manufacturers Representative attendance during Commissioning of the process system which includes the gates specified in this Section to ensure that each gate functions as intended in the process system.

END OF SECTION

DOWNWARD OPENING WEIR GATES

1. GENERAL

1.1 Work Included

.1 This Section specifies the supply and supervision of the installation and Commissioning of downward opening weir gates.

1.2 Submittals

.1 Shop Drawings: Submit in accordance with Section 01300 and Section 11005.

.2 For each type of gate or weir, provide:

.1 Frame assembly details.

.2 Concrete embedment and attachment details.

.3 Installation instructions.

.3 For each gate, provide:

.1 Operator details.

.2 Stem and Yoke details

.3 Seal Details.

.4 Operating and Maintenance Data: Provide for incorporation in operation and maintenance (O&M) manual as specified in Section 01735.

.5 Design calculations and supporting data for all gates showing stresses, loads and deflection for critical parts under design head conditions.

1.3 Performance

.1 Weir gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.01 L/s per metre of seal periphery under the design seating head and 0.02 L/s per metre of seal periphery for the design unseating head.

.2 Weir gates shall be designed to withstand the maximum design head (maximum design head shall be taken as the height of the slide unless otherwise shown in the schedule).

.3 The weir gate's sealing system should have been tested through a cycle test in an abrasive environment and should show that the leakage requirements are still obtained after 25,000 cycles with a minimum deterioration.

2. PRODUCTS

2.1 General

.1 Shop assemble and inspect gates to ensure that field fitting will not be required.

2.2 Acceptable Manufacturers

.1 Fontaine

.2 Armtec

.3 Rodney Hunt

.4 Whipps

2.3 Weir Gates

.1 Weir gates shall be either self-contained or non self-contained of the rising stem or non-rising stem configuration as indicated on the gate schedule.

.2 The gate frame shall be constructed of structural members or formed plate welded to form a rigid one piece-frame. The frame shall be of the integral flange back design suitable for mounting on a concrete wall (CW). The guide slot shall be made of the “True” ultra high molecular weight polyethylene (UHMWPE).

.3 The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to 1/720 of the gate's span under the design head.

.4 The guides shall be made of the “True” UHMWPE and shall be of such length as to retain and support at least two thirds (2/3) of the vertical height of the slide in the fully open position.

.5 The bottom and side seals shall be made of the “true” UHMWPE of the self adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide.

.6 Seals shall maintain the specified leakage rate in both seating and unseating conditions.

2.4 Lift Assemblies

.1 The operating stem shall be of stainless steel designed to transmit in compression at least two (2) times the rated output of the operating manual mechanism with a 178 N effort on the crank or handwheel.

.2 The stem shall have a slenderness ratio (L/R) less than 200. The threaded portion of the stem shall have machined cut threads of the Acme type.

.3 Where a hydraulic, pneumatic or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.

.4 For stems in more than one (1) piece and with a diameter of 45 mm and larger, the different sections shall be joined together by solid couplings. The couplings shall be grooved and keyed and shall be of greater strength than the stem. Stems with a diameter smaller than 45 mm shall be pinned to an extension tube.

.5 Gates having a width equal to or greater than two (2) times their height shall be provided with two (2) lifting mechanisms connected by a tandem shaft.

.6 Stem guides shall be fabricated from stainless steel. The guide shall be equipped with an ultra high molecular weight polyethylene (UHMWPE) bushing. Guides shall be adjustable and spaced in accordance with the Manufacturer's recommendation. The L/R ratio shall not be greater than 200.

.7 Rising stem gates shall be provided with a clear polycarbonate stem cover. The stem cover shall have a cap and condensation vents as well as a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

2.5 Lifting Mechanism.

.1 Operators of the types listed in the schedule shall be provided by the gate Manufacturer. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 178 N on the crank or handwheel and shall be able to withstand, without damage, an effort of 356 N.

.2 Gearboxes shall be provided when required to maintain the operating force below 178 N. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank-operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings. The operating shaft shall be fitted with a 50 mm square operating nut and removable crank. The crank shall be fitted with a corrosion-resistant rotating handle. The maximum crank radius shall be 380 mm and the maximum handwheel diameter shall be 600 mm.

.3 Self-contained gates shall be provided with a yoke made of structural members or formed plates. The maximum deflection shall be 1/360 of the gate's span.

2.6 Materials

Part	Material
Frame, yoke, stem guides, slide, stem extension	Stainless Steel American Society for Testing and Materials (ASTM) A-240, Type 304L or 316L
Guides, side and bottom seals, stem guide liner	Ultra high molecular weight polyethylene (UHMWPE), ASTM D-4020-96
Compression cord	Nitrile ASTM D-2000 M6BG 708, A14, B14, E014, E034
Threaded stem	Stainless steel ASTM A-276, Type 303 MX or 316
Fasteners	ASTM F593 and F594 GR1 for type 304 and GR2 for type 316
Pedestal, handwheel, crank	Tenzaloy aluminum Alloy ZC81A
Gasket (between frame and wall)	EPDM ASTM 1056
Stem cover	Polycarbonate ASTM A-707
Lift nut	Manganeze bronze , ASTM B584, UNS-C86500

3. EXECUTION

3.1 Manufacturer's Representative

.1 Manufacturer’s Representative shall be required to attend the Site to train installation personnel; and to witness installation and testing to ensure the equipment is installed and operated as intended.

3.2 Installation

.1 Coordinate blockouts or cast in place items.

.2 Install slide gates with square corners, in a vertical plane, with tolerances within Manufacturer's recommendations.

.3 Install gate operators as per Manufacturer’s recommendations. Align to ensure there is no distortion of stems or moving parts.

.4 Install weir plates as shown in the Drawings.

3.3 Testing

.1 Operate each gate with and without liquid to show that each can be operated with applied torques within design limits.

.2 Test each gate for leakage by filling the channel on one (1) side of the gate and measuring leakage through the gate. Undertake the test after twenty-four (24) hours to allow for the concrete to absorb water.

3.4 Commissioning

.1 Arrange Manufacturers Representative attendance during Commissioning of the process system which includes the gates specified in this Section to ensure that each gate functions as intended in the process system.

END OF SECTION

INSTALLATION OF UV INFLUENT PUMP EQUIPMENT

1. GENERAL

1.1 Work Included

.1 This Section specifies the installation, testing, and Commissioning of the influent pumps for the Ultraviolet (UV) Disinfection Facility.

.2 The axial flow influent pumps will be supplied by the City via a separate Contract - Contract No. 89-2005 for the Supply of Vertical Axial Flow Propeller Pumps with Variable Frequency Drives Complete with Fabricated Draft Tube and Interconnecting Pipework for the North End Water Pollution Control Centre Disinfection Project (hereafter referred to as the UV Influent Pump Supply Contract). Contract No. 89-2005 is being tendered simultaneously with this Contract.

.3 The UV Influent Pump Supply Contract includes the following:

.1 Fabrication and factory testing of the pumps;

.2 Fabrication of the intake pipes, pump cans, and draft tubes, and couplings;

.3 Supplying of variable frequency drive (VFD), harmonic filters, and associated equipment;

.4 Supplying of power and control cables between the pumps and the disconnect panels;

.5 Supplying and delivering equipment to the City's storage facility;

.6 Off-loading and inspecting delivered equipment;

.7 Providing installation training for the equipment;

.8 Supervising the installation of the equipment;

.9 Supervising equipment testing;

.10 Operations and maintenance training for the equipment;

.11 Providing operating and maintenance (O&M) manuals for the equipment;

.12 Providing As-Built Drawings for the equipment;

.13 Providing technical support and remedying defects in the equipment during the warranty period for the UV Influent Pump Supply Contract.

.4 Responsibilities of the Contractor include, but are not limited to:

.1 Supply and install power feeder cables from the plant electrical system to the main disconnect panels for each pump;

.2 Supply and install disconnect panels;

.3 Supply and install pump access hatches;

.4 Supply and install anchor bolts;

.5 Install all piping, pump cans, draft tubes, variable frequency drives, cables, wiring, and materials provided under the UV Influent Pumps Supply Contract;

.6 Install power and control cables between the pumps and the disconnect panels;

.7 Coordinate installation training for the equipment;

.8 Transport the equipment from the City's storage facility to the Site;

.9 Take delivery of, store and protect all equipment and materials;

.10 Undertake Commissioning of the equipment;

.11 Undertake equipment testing of the equipment;

.12 Coordinate operation and maintenance training for the equipment.

.5 The City will be responsible for configuration of the communication software between the pump control system and the Bailey distributed control system (DCS).

1.2 Coordination

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

2. EXECUTION

2.1 Manufacturer's Representative

.1 A technically qualified Manufacturer's Representative will be provided under the UV Influent Pump Supply Contract. Arrange for the Manufacturer's Representative to:

.1 Attend and certify equipment delivery;

.2 Attend and certify installation training;

.3 Attend and certify equipment installation;

.4 Attend and certify equipment performance testing;

.5 Provide initial and final operation and maintenance training.

2.2 Delivery, Protection, and Storage

.1 The equipment will be delivered and off-loaded at the City's storage facility, under the UV Influent Pump Supply Contract. The City will take custody and store the equipment until required by the Contractor. The City's storage facility will likely not be located at the NEWPCC, but will be located in Winnipeg.

.2 Take custody, deliver to Site, store and protect the equipment as soon as it is handed-over by the City. Execute Form 200, Certificate of Equipment Delivery, in the UV Influent Pump Supply Contract.

.3 The Contractor shall be responsible for delivering the equipment from the City's storage facility to the Site. The Contractor's responsibilities shall include loading, transportation and off-loading of the equipment.

.4 Store the equipment in accordance with the Manufacturer's recommendations.

.5 Spare parts for the equipment provided under the UV Influent Pump Supply Contract will initially be stored at the City's storage facility. Coordinate with the City and Contract Administrator as to which spare parts are to be delivered by the Contractor to the Site and which spare parts are to be retained at the City's storage facility.

2.3 Installation

.1 Receive installation training from the Manufacture's Representative provided under the UV Influent Pump Supply Contract. Execute Form 201, Certificate of Instruction, in the UV Influent Pump Supply Contract.

.2 Follow the written installation instructions and Drawings provided by Supplier of the equipment in the UV Influent Pump Supply Contract.

.3 Ensure the equipment is installed as required to provide satisfactory service.

.4 The pump housings (cans, draft tubes, intake laterals) shall be installed simultaneously with the construction of the adjacent structures (secondary effluent channel and the pump discharge boxes and UV influent channel), to form an integral part of the complete structure.

2.4 Commissioning

.1 The Contractor is responsible for commissioning of the process systems which includes the equipment specified in this section and to ensure the equipment functions as intended in the process systems.

2.5 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 Cooperate with the Supplier of the equipment in the UV Influent Pump Supply Contract to fulfill the requirements for successful testing of the equipment. Execute Form 203, Certificate of Equipment Satisfactory Performance.

2.6 Training

.1 Arrange and coordinate the operation and maintenance training included in the scope of services specified in the UV Influent Pump Supply Contract.

END OF SECTION

INSTALLATION OF UV DISINFECTION EQUIPMENT

1. GENERAL

1.1 Work Included

.1 This Section specifies the installation, testing, and Commissioning of the ultraviolet (UV) light disinfection equipment.

.2 The UV equipment will be supplied by the City via a separate Contract - Contract No. 257-2004 for the Supply of Ultraviolet Light Disinfection Equipment for the North End Water Pollution Control Centre Disinfection Project (hereafter referred to as the UV Supply Contract). Contract No. 257-2004 was awarded to Trojan Technologies Inc. in October 2004.

.3 The UV Supply Contract includes the following:

.1 Fabrication and factory testing of the UV equipment;

.2 Supplying and delivering UV equipment to the City's storage facility;

.3 Off-loading and inspecting delivered UV equipment;

.4 Providing installation training for the UV equipment;

.5 Supervising the installation of the UV equipment;

.6 Supervising UV equipment performance testing;

.7 Supervising UV process performance testing;

.8 Operations and maintenance training for the UV equipment;

.9 Undertaking Guaranteed Performance Testing for the UV equipment;

.10 Providing operating and maintenance manuals for the UV equipment;

.11 Providing As-Built drawings for the UV equipment;

.12 Providing technical support and remedying defects in the UV equipment during the warranty period for the UV Supply Contract.

.4 Responsibilities of the Contractor include, but are not limited to:

.1 Supply and install power feeder cables from the plant electrical system to the Power Distribution Centers (PDCs) of the UV equipment;

.2 Supply and install data communication cable between UV control panel UVCP1 and the UV System Control Centre (SCC);

.3 Supply and install all stop-logs and automatically actuated weir gates;

.4 Supply and install anchor bolts;

.5 Supply and install decking for channels;

.6 Transport UV equipment from the City's storage facility to the Site;

.7 Take delivery of, store and protect all UV equipment and materials;

.8 Coordinate installation training for the UV equipment;

.9 Install all equipment and materials provided under the UV Supply Contract;

.10 Undertake commissioning of the UV equipment;

.11 Undertake equipment performance testing of the UV equipment;

.12 Undertake process performance testing of the UV equipment;

.13 Coordinate operation and maintenance training for the UV equipment.

.5 The City will be responsible for software configuration of the interface between the UV equipment SCC and the Bailey DCS.

1.2 Coordination

.1 Coordinate with other Divisions to ensure that there is no conflict with the Work.

2. EXECUTION

2.1 Manufacturer's Representative

.1 Trojan Technologies Inc. will provide a technically qualified Manufacturer's Representative. Arrange for the Manufacturer's Representative to:

.1 Attend and certify equipment delivery;

.2 Attend and certify installation training;

.3 Attend and certify equipment installation;

.4 Attend and certify equipment performance testing;

.5 Attend and certify process performance testing;

.6 Provide initial and final operation and maintenance training.

2.2 Delivery, Protection, and Storage

.1 The UV equipment will be delivered and off-loaded by Trojan Technologies Inc. The City will take custody and store the equipment until required by the Contractor. The City's storage facility will likely not be located at the NEWPCC, but will be located in Winnipeg.

.2 Take custody, deliver to Site, store and protect the UV equipment as soon as it is handed-over by the City. Execute Form 200, Certificate of Equipment Delivery, in the UV Supply Contract.

.3 The Contractor shall be responsible for delivering the UV equipment from the City's storage facility to the Site. The Contractor's responsibilities shall include loading, transportation and off-loading of the equipment.

.4 Store the UV equipment in accordance with the requirements specified by Trojan Technologies Inc.

.5 Spare parts for the equipment provided by Trojan Technologies Inc. will initially be stored at the City's storage facility. Coordinate with the City and Contract Administrator as to which spare parts are to be delivered by the Contractor to the Site and which spare parts are to be retained at the City's storage facility.

2.3 Installation

.1 Receive installation training from Trojan Technologies Inc. Execute Form 201, Certificate of Instruction, in the UV Supply Contract.

.2 Follow the written installation instructions and drawings provided by Trojan Technologies Inc.

.3 Ensure the equipment is installed as required to provide satisfactory service.

.4 The UV reactors shall be installed prior to the completion of the building, specifically prior to construction of the roof.

2.4 Commissioning

.1 The Contractor is responsible for Commissioning of the process systems which includes the equipment specified in this Section and to ensure the equipment functions as intended in the process systems.

2.5 Testing

.1 Ensure the equipment, including all component parts, operates as intended.

.2 For the UV equipment system testing requirements, refer to instructions provided by Trojan Technologies Inc. and to the requirements outlined in the UV Supply Contract.

.3 Cooperate with Trojan Technologies Inc. to fulfill the requirements for successful testing of the equipment. Execute Form 203, Certificate of Equipment Satisfactory Performance.

2.6 Training

.1 Arrange and coordinate the operation and maintenance training included in the scope of services specified in the UV Supply Contract.

END OF SECTION

FIELD APPLIED CORROSION PROTECTIVE AND MAINTENANCE COATINGS

1. GENERAL

1.1 Work Included

.1 Provide, apply and maintain the specified field applied protective and maintenance coating systems. Coatings are required on all process and mechanical equipment, vessels and pipes unless specifically accepted.

.2 Refer to Drawings and Schedules for the type, location, and extent of coatings required and included for all field coating necessary to complete all the Work shown, specified or scheduled.

1.2 Delivery and Storage

.1 Deliver all coating materials to the Site in sealed containers properly labelled to indicate the Manufacturer's name, type and colour of contents, date of manufacture, batch number, and storage requirements.

.2 Provide adequately heated and ventilated storage for all materials and ensure compliance with fire prevention regulations.

2. PRODUCTS

2.1 Manufacturers

.1 All constituents of each coating system are to be provided by the same Manufacturer.

.2 Acceptable Manufacturers: Valspar, Sherwin Williams, Benjamin Moore

2.2 Schedule of Surface Treatments

.1 The Schedule of Surface Treatments defines the components of the protective coating system.

Schedule of Surface Treatments

Ref.	Description	Surface Treatments
A	Solvent Cleaning	As SSPC-SP1
B	Hand Tool Cleaning	As SSPC-SP2
C	Power Tool Cleaning	As SSPC-SP3
D	Brush Blast	As SSPC-SP7
E	Near White Metal Blast	As SSPC-SP10
F	White Metal Blast	As SSPC-SP5 (NACE #1)
G	Abrasion	Lightly abrade surface using steel wool or abrasive cloth to provide a key for the next coat, to remove runs or excessive brush marks.
H	Vinyl Wash Primer	DFT 13 microns. Over-coat within 24 hours
I	Zinc Chromate Primer	Nominal DFT 40 microns
J	Inorganic Zinc Primer	Zinc in ethyl silicate vehicle. Minimum DFT 40 microns
K	Industrial Enamel (to 100ºC)	To 1-GP-61M Alkyd Enamel. Minimum DFT 30 microns
L	High Built Epoxy	To AWWA C210 and certified by an appropriate testing agency (NSF Std. 61, CSA, etc.) for use on wastewater applications. Minimum DFT 200 microns
M	Bituminous Paint	To AWWA C230, MIL-P-151470
N	Silicone Alkyd (100ºC to 150ºC)	Min. 60% solids by weight. Nominal DFT 40 microns
O	Silicone Enamel (150ºC to 400ºC)	To 1-GP-143M, DFT 40 microns
P	Fast Drying Aluminum Sealer	To 1-GP-69M, Nominal DFT 25 microns
Q	Canvas Insulation Sealer	Acrylic or PVA latex
R	Epoxy Gloss Enamel	To 1-GP-146, nominal DFT 50 microns

SSPC: Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, PA 15213
Surface Preparation Specifications, March 1985.

2.3 Schedule of Protective Systems

.1 The schedule of protective systems defines the combination of surface treatments required in each system and the sections of the plant to which it is to be applied. The systems have been grouped into three (3) categories as follows:

.1 Category A: Immersed Service, equipment or material fully, partially or intermittently immersed in water during routine plant operation.

.2 Category B: Exposed Service, equipment or material exposed to the normal range of atmospheric conditions and conditions common to wastewater treatment facilities (high humidity, etc.)

.3 Category C: Indoor Service, equipment or materials inside buildings or other ventilated spaces.

2.4 Category A

.1 All Category A systems will be tested by the Contract Administrator using a wet sponge holiday detector set at 67.5 volts. Touch up will be required at points where the detector is grounded.

.2 Schedule:

Schedule of Systems

System	Surface Treatments	Typical Applications
A1	A, D, L, L	Equipment or piping delivered with inorganic zinc primer, e.g. clarifier mechanics, mixers, etc.
A2	A, F, J, L, L	Equipment or piping delivered uncoated or with coatings not compatible with epoxy, e.g. ductile iron, cast iron or steel pipe and pipe sleeves inside treatment units. External Surfaces at valves, fabricated pipe supports, brackets, etc.
A3	A, G, M	Aluminum surfaces in contact with concrete, e.g. access cover frames
A4	A, E	Ferrous metal surface cast into concrete, e.g. penstocks, pipe sleeves
A5	A	Stainless steels, plastics, and fibreglass products

2.5 Category B

.1 Schedule:

Schedule of Systems

System	Surface Treatments	Typical Applications
B1	A, B, R, R	Equipment or piping delivered with inorganic zinc primer, e.g. motors, flocculator gearbox & motor, valve headstocks, piping above ground & outside treatment units, hydrants, etc.
B2	A, B, J, R, R	Equipment or piping delivered but not applied with an inorganic zinc prime coat or with a prime coat not compatible with an inorganic zinc overcoat.
B3	A, B, H, R, R	Galvanized or cadmium plated goods, e.g. pipe supports or brackets, mountings for electrical or control equipment (Unistrut, etc.)
B4	A	Stainless steel or aluminum products, e.g. insulation recovering

2.6 Category C

.1 Schedule

Schedule of Systems

System	Surface Treatments	Typical Applications
C1	A, B, K, K	Equipment or piping delivered c/w factory finished coatings. Coated for system identification and maintenance. Surface temperature during operation not exceeding 100ºC, e.g. pumps, air handling units, valves, etc.
C2	A, G, K, K	Equipment or accessories fully primed. Surface temperatures not exceeding 100ºC, e.g. pumps, steel piping
C3	A, C, I, N, N	Equipment or accessories as C1 or C2 but with operating surface temperatures between 100ºC and 150ºC, e.g. air compressors, blowers
C4	E, J, O	Equipment or accessories as C1 or C2 but with operating surface temperatures between 150ºC and 400ºC, e.g. boiler fittings
C5	B, P, K, K	Piping or valves with bituminous or tar coatings. Surface temperatures not exceeding 100ºC, e.g. cast iron & ductile iron pipe, valves.
C6	A, K, K	PVC pipe, fittings or accessories coated for identification only.
C7	A, H, K, K	Aluminum insulation recovering coated for identification only.
C8	A, Q, G, N, N	Canvas insulation recovering.

NOTE:
(1) Surface preparation G-abrasion has not been fully scheduled but is to be carried out between all coatings.
(2) No bare ferrous metal surfaces are permitted. Pipe hanger rods etc., unless zinc or cadmium plated, are to be at least prime coated. Cut ends of plated surfaces (Uni-strut, etc.) are to be spot primed.

2.7 Colour Coding

.1 Not Used

3. EXECUTION

3.1 Quality Assurance

.1 Apply all paints and coatings strictly in accordance with the Manufacturer's directions.

.2 Pay particular attention to ensure the compatibility of each surface treatment with the preceding and subsequent surface treatments and coatings. Ensure the compatibility of all surface treatments and coatings.

.3 Coatings exhibiting visible defects such as drips and runs will not be accepted.

3.2 Environmental Conditions

.1 Do not apply a coating when the ambient or surface temperature is below 10°C or less than 3°C above the dew point.

.2 Provide adequate ventilation and sufficient heating to maintain temperatures above 7°C for twenty-four (24) hours before coatings are applied. Continue heating to maintain 10°C during application and for forty-eight (48) hours after application.

.3 Provide a minimum of 300 lux illumination on surface to be treated.

.4 Do not apply coatings where dust is being generated.

3.3 Protection

.1 Provide sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted. Make good any damage resulting from inadequate or unsuitable protection.

.2 Maintain all coated surfaces until completion of the Works. Damage to coatings, occurring at any time, shall be made good within seven (7) days.

.3 Place cotton waste, cloths and material which may constitute a fire hazard in closed metal containers and remove from the Site at suitable intervals.

.4 Remove and, after painting, replace or adequately mask all grease nipples, bright metal surfaces, identification plates and other items not to be painted. Do not use solvent that may remove permanent lacquer finishes.

3.4 Condition of Surfaces

.1 Thoroughly examine all surfaces to be treated or coated prior to commencement of Work. Report, in writing, to the Contract Administrator any condition or defect that may affect the integrity or quality of the finished coating. Do not commence Work on any Section until all such defects in that Section have been corrected.

.2 On all factory primed or coated equipment, touch up defects prior to the application of subsequent coatings.

.3 Be responsible for the condition of surfaces and for correcting defects and deficiencies in the surface.

END OF SECTION

FACTORY APPLIED CORROSION PROTECTIVE AND MAINTENANCE 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. Alternative coating systems may be submitted for review, 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: For ferrous components, degrease and dry blast 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) #1. Obtain a 50 micron blast profile.

.2 Non-Immersion Service: After degreasing, as a minimum, hand tool clean all surfaces in accordance with SSPC-SS2 or power tool clean in accordance with SSPC-SS3.

2.2 Prime Coating

.1 Coat all ferrous surfaces before the blasted surfaces deteriorate.

.2 To ferrous surfaces apply inorganic zinc primer, containing a minimum of 50% solids by volume, to a minimum dry film thickness of 75 micron.

2.3 Finish Coats

.1 Apply finish coats in conformance with Section 11900 for service, coating types and application rates.

2.4 Assembly

.1 Before the parts are assembled, clean and coat surfaces of items that are to be bolted together before shipment.

.2 Make all welded connections continuous weld, sealing the mating surface completely. On completion of the welding and fettling, treat all weld seams with phosphoric acid solution, then rinse and thoroughly dry before the primer is supplied.

.3 Where dissimilar metals are mated, insulate the surfaces from one (1) another to provide protection against galvanic or other corrosion.

.4 For immersion service, use 316 stainless steel nuts, bolts, washers and similar fittings. For non-immersion service use 304 stainless nuts, bolts, washers, and similar fittings. Clean and coat the inner face of bolt holes, not threaded, as required for other surfaces.

3. EXECUTION

3.1 Inspection

.1 Notify the Contract Administrator two (2) weeks before commencing the protective coating in order to facilitate the inspection by the Contract Administrator of the surface preparation and protective coating application.

3.2 Protection

.1 Adequately protect all coated equipment 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 the equipment and recoat at no cost to the City.

END OF SECTION

UV INFLUENT PUMPING DESIGN AND OPERATING DESCRIPTION

1. INTRODUCTION

.1 Pumps and related electrical systems are City supplied. The Contractor shall be responsible for supplying, installing, and Commissioning of the pump control systems.

.2 Secondary Effluent (SE) leaves the clarifiers via a pair of rectangular conduits. Up to 400 ML/d of the flow is diverted to one conduit only at the Primary Effluent Bypass Junction structure. The flow is conveyed in this single conduit for approximately 150 m to the existing Effluent Gate Chamber (EGC).

.3 SE enters a new channel connected to the future outfall connection of the EGC. The new channel terminates in a deep section which serves as a pump intake sump. Five (5) laterals convey flow to five (5) vertically mounted axial flow propeller pumps mounted in individual "cans". The pumps discharge into individual boxes set higher than the receiving channel water level, providing a passive backflow protection, with no need for valves or flapgates.

.4 The SE flows down a channel and is distributed into the three (3) UV Reactor Channels.

2. DESIGN

2.1 Description

.1 SE flows through a channel to a structure where five (5) submersible axial flow propeller pumps are installed in vertical draft tubes. The pumps are removable with an overhead crane for repair, maintenance, and replacement.

.2 Because flows vary throughout the day, the pumps are equipped with variable frequency drives (VFDs). The pump(s) speed modulates to maintain a relatively constant level in the intake sump between the minimum submergence and overflow levels.

.3 There are five (5) pumps, each sized to pump one-fifth (1/5) of the maximum flow. No standby pump is installed; a sixth unit will be available on the shelf. Because the pumps are relatively easy to remove and install, this reduces the size of the pump intake and discharge structure by approximately 20%.

.4 Each pump will pump between 42 ML/d and 86 ML/d at a static head of 6 to 6.5 m

.5 The pumps will be restricted to a maximum combined flow of approximately 410 ML/d. Flow in excess of this amount will be allowed to back up into the Primary Effluent (PE) Channel and spill over the PE bypass weirs directly into the outfall conduit.

2.2 Design Criteria

.1 Five (5) pumps will be installed at this stage, each sized to accommodate 100% of the minimum flow to 20% of the maximum flow (approximately). Each pump will be variable speed. The level in the wetwell (SE channel) will control the speed of the pumps between their minimum and maximum pumping rates. Signals from level sensor(s) in the intake control the pump speed to maintain the set level.

.2 The water depth will be maintained at between 226.12 m ASL (above sea level) (4.3 m above plant datum) to provide at least 1,800 mm above the centre line of the pump intake lateral, and a maximum water level of 226.62 m ASL (4.8 m above plant datum).

.1 Main Inlet Channel Invert: 225.478 m ASL / 3.658 m APD (above plant datum)

.2 Pump Intake Channel and Pipe Invert: 223.72 m ASL / 1.900 m APD

.3 Pump Intake Pipe Centre Line: 224.32 m ASL / 2.5 m APD

.4 Normal LWL (low water level): 226.12 m ASL / 4.3 m APD

.5 Normal Operating Water Level: 226.37 / 4.55 m APD

.6 Normal HWL (high water level): 226.62 ASL / 4.8 m APD

.7 Pump Shut-off Level: 225.82 / 4.0 m APD

.8 Overflow Level: 227.12 m ASL / 5.3 m APD

.3 As the influent flow increases and the water level in the channel rises, the pumps' speeds will increase to prevent SE from rising above HWL (26.62 m), and spilling over the UV bypass weir (227.12 m). At flows less than or equal to 430 ML/d, the pumps turn on and off or speed up and slow down to maintain the water level between the minimum submergence level and the maximum water level.

.4 Flow into the secondary treatment system will be restricted to 380 ML/d at the inlet to the existing High Purity Oxygen (HPO) reactors. Excess flow will overflow at the PE bypass structure. The influent control at the HPO reactors is not precise, and allowance is made for the pumps and UV structure to hydraulically accommodate up to 430 ML/d. Under normal circumstances, the flow into the pump intake will not exceed 380 ML/d.

.5 Each pump is mounted in a 1,000 mm diameter vertical tube, which discharges vertically into individual discharge boxes set approximately 500 mm above HWL in the receiving channel, preventing backflow when a pump is not operating.

2.3 Design Data

Description	Units	Design Value
Duty		5
Standby		1 (on shelf)
Capacity (maximum, each)	L/s	995
Capacity (minimum, each)	L/s	486
Discharge tube diameter	mm	1,000 maximum
TDH	m	6-0 - 6.5
Power, each	kW	127 maximum
Firm capacity total	ML/d	410 – 430 (APPROX)
Minimum Submergence	m	1.800
Wetwell (SE channel) floor invert	m	223.42

Description	Units	Design Value
Pump Intake Pipe Centre Line	m	224.32
Minimum water level at pump intake	m	226.12
Bypass weir elevation	m	227.12
Maximum water level	m	226.62
High High alarm level (bypass occurring)	m	227.12
High alarm (bypass imminent)	m	226.82
Minimum water level (pump stop)	m	225.82

2.4 Arrangement

.1 The pump inlet channel abuts the eastern side of the EGC structure. The PE enters a deeper section of channel, and is withdrawn to the pumps by five (5) 1,200 mm diameter laterals [one (1) per pump].

.2 The five (5) pumps are mounted in individual "cans" and discharge tubes which discharge to a channel upstream of the UV reactors.

.3 The UV system is sized for a peak flow of 380 ML/d (disinfection capacity) and approximately 430 ML/d (hydraulic capacity). The pumps installed at this stage will be sized to convey approximately 410 - 430 ML/d.

2.5 Other Disciplines

.1 Structural/Building Services

.1 The floor of the pump intake area must be at an elevation to provide an overall minimum submergences.

.2 The length and width of the pump intake area must meet the minimum requirements to optimize flow conditions through each pump.

.3 The enclosure over the pump structure must provide adequate access to allow the pumps to be removed by crane or hoist.

.4 Each pump weighs approximately 1,700 kg; the can and discharge tube assembly is estimated to weigh 11,000 kg.

.2 Mechanical

.1 The pump structure is an enclosed underground structure and does not require general ventilation.

.3 Electrical

.1 The electrical room and electrical service must be sized for the major items of equipment installed summarized in the following table.

Description	Tag	Full Load (kW)
UV Influent Pump 1	U010-P1	100 – 130
UV Influent Pump 2	U020-P1	100 – 130
UV Influent Pump 3	U030-P1	100 – 130
UV Influent Pump 4	U040-P1	100 – 130
UV Influent Pump 5	U050-P1	100 – 130
TOTAL PUMP LOAD		
UV Lamps		
TOTAL UV LOAD		
Miscellaneous		

3. OPERATING DESCRIPTIONS

3.1 Control Devices

Description	Location	Number	Function
U010-VFD1	Central	1	Match pump 1 output to inflow, up to 995 L/s
U020-VFD2	Central	1	Match pump 2 output to inflow, up to 995 L/s
U030-VFD3	Central	1	Match pump 3 output to inflow, up to 995 L/s
U040-VFD4	Central	1	Match pump 4 output to inflow, up to 995 L/s
U050-VFD5	Central	1	Match pump 5 output to inflow, up to 995 L/s
U005-LE U005-LIT U005-LT	Local	1	Controls pump VFDs to maintain wetwell water level
U060-LE U060-LIT U060-FT	Local	1	Measure flow by depth over inlet weirs
U170-LE U170-LIT U170-LT	Local	1	Water Depth at UV Channel 1 outlet
U270-LE U270-LIT U270-LT	Local	1	Water Depth at UV Channel 2 outlet
U370-LE U370-LIT U370-LT	Local	1	Water Depth at UV Channel 3 outlet
U102-ZSB			UV outlet weir gate closed
U102-ZSD			UV outlet weir gate open
U102-ZIT			UV outlet weir gate position
U102-HS1/HS2/HS3			UV outlet weir gate HOA
U202-ZSB			UV outlet weir gate closed
U202-ZSD			UV outlet weir gate open
U202-ZIT			UV outlet weir gate position
U202-HS1/HS2/HS3			UV outlet weir gate HOA

Description	Location	Number	Function
U302-ZSB			UV outlet weir gate closed
U302-ZSD			UV outlet weir gate open
U302-ZIT			UV outlet weir gate position
U302-HS1/HS2/HS3			UV outlet weir gate HOA
Off/On Switch	Central	5	Turn pumps on and off from central control
HOA Switch	Local	5	Turn pumps control from central (AUTO) to OFF to local (HAND)
Start/Stop	Local	5	Start and stop pumps in local control mode

3.2 Normal

.1 Automatic (local HOA selector switch in AUTO)

.1 The pumps maintain a relatively constant liquid level in the wetwell and generally pump the SE at the same rate as it arrives from the secondary clarifiers.

.2 During normal operation all five (5) pumps will be available for operation, and will run, depending on the flow. The lead and lag pump roles will alternate.

.3 All five (5) pumps are placed in AUTO mode at the local panel and ON at the central control system.

.4 The speed of the pumps and the number of pumps in operation is controlled by the level in the inlet. One (1) to five (5) pumps normally run continuously, unless the water level falls below the minimum operating level and approaches the level corresponding to the minimum submergence requirement. If this occurs while the pump(s) is/are running at minimum speed, it/they will shut down.

.1 Water levels used for pump control are as follows:

.1 225.82 m (4.0 m): minimum pump submergence level; all pumps shut off

.2 226.12 m (4.3 m): approximate normal operating level with operating pump(s) running at minimum speed (operating pumps will adjust speed to maintain this level)

.3 226.62 m (4.8 m): Operating pump(s) will speed up if they are running at less than maximum speed if this level cannot be maintained

.4 226.82 m (5.0 m): Normal HWL at which next duty pump will start. If all duty pumps are operating at maximum speed (> 380 ML/d combined) the water level will be allowed to rise to overflow 227.12 m (5.3 m).

.5 227.12 m (5.3 m): Overflow weir level

.2 At effluent flows between 85 and 170 ML/d, two (2) pumps will run; water level should be maintained at about 226.37 m. If influent flow drops below the

minimum pumping rate of 42 ML/d per pump while the two (2) pumps are at minimum speed, the water level will drop. One (1) pump will shut off in this event. If the inflow is less than 42 ML/d, the last operating pump will shut off when the water level drops to the shutoff level.

.3 As flows increase, the increase in water level will cause additional pumps will start. All operating pumps will be controlled to run at the same speed.

.5 High alarm level is 226.82 m (bypass to outfall is imminent). There are three (3) possible responses to this condition:

.1 If five (5) pumps are running at maximum speed: Normally, as it is permissible to bypass the UV process when flows exceed 380 ML/d, this high level alarm is an "information alarm" only, indicating that bypass of the UV influent pumps is about to occur; the pumps will not speed up past their combined imposed limit of 410 to 430 ML/d. The flow into the pump intakes should not exceed this under normal conditions as the flow is restricted to 380 ML/d at a remote point upstream.

.2 All running pumps should be running at maximum speed if the water rises to this level. If, however, the pumps are not running at maximum speed, the pumps will speed up, and the next duty pump [if four (4) or fewer pumps are operating] will start to prevent overflow into the bypass, up to their combined imposed limit of 410 ML/d.

.3 If High level alarm occurs in conjunction with another alarm that indicates failure or malfunction of a pump, another pump will be started.

.6 High High alarm 227.12 m (bypass to outfall is occurring). There are three (3) possible responses to this condition:

.1 If five (5) pumps are running at maximum speed: Normally, as it is permissible to bypass the UV process when flows exceed 380 ML/d, this alarm is an "information alarm" only, indicating that bypass of the UV is occurring; the pumps will not speed up past their combined imposed limit of 410 ML/d.

.2 All running pumps should be running at maximum speed if the water rises to this level. If, however, the pumps are not running at maximum speed, the pumps will speed up, and the next duty pump [if four (4) or fewer pumps are operating) will start in an attempt to prevent overflow into the bypass, up to their combined imposed limit of 410 – 430 ML/d.

.3 If High level alarm occurs in conjunction with another alarm that indicates failure or malfunction of a pump (at flows less than 330 ML/d), another pump will be started.

.7 Low level alarm is 225.82 m (approximately 300 mm above minimum required pump submergence, indicating pump shutdown is imminent). The pumps will continue to run, but will slow down to try to maintain the water level at this elevation. If the water level drops with all running pumps at minimum speed, they will shut down one by one, until no pumps are in operation.

.8 The lead pump will restart first when the influent level to rises above 226.37 m after all pumps have been shut down

.9 The number of pumps running, and the speed at which they are running, is controlled to maintain a relatively constant level in the wetwell (SE channel) at about 226.37 m.

.10 The level transmitter (U-005) measures the water level in the wetwell. The signal is sent to the control system, which uses the setpoints for start, stop, speed control, and alarms for the pumps.

.11 A float switch provides a mechanical backup to stop the pump at LWL if the signal from the ultrasonic unit is compromised.

.12 Motor status and HOA status of each pump are output to the Computer Control System.

.2 Manual (Local HOA selector switch in HAND, and start/stop button on START)

.1 Each pump that is in MANUAL will run continuously, regardless of the level in the wetwell (PE channel) or signal from the flow meter, until it is shut off (start/stop button on STOP or HOA placed in OFF or AUTO).

.2 The pump will run at the speed set at the VFD

.3 Startup

.1 To start the pumps, place the HOA on AUTO and ensure that all control inputs (wetwell levels, flow signals, speed controllers etc) are functional. Ensure the suction and discharge structures are unobstructed. The pumps will start and vary their speed automatically in response to the level in the wetwell.

.2 Normally, two (2) pumps will operate in tandem until flow exceeds 170 ML/d. When this occurs, a third pump will start, and the lead pumps will slow down, and the pumps will run at the same speed. Above 250 ML/d, a fourth pump starts. All running pumps ramp down and match speed to pump the incoming wastewater. If the inflow exceeds 330 ML/d, the fifth pump starts. Again, all operating pumps ramp down to match each other's speed. All four (4) pumps then ramp up to match inflow if it increases beyond this point. At 410 ML/d, all five (5) pumps should be running at maximum speed. Higher flows should not occur as the flow into the upstream process is limited to 380 ML/d.

.3 The pumps alternate lead/lag/standby roles.

.4 Shutdown

.1 From the central control system, any pump can be stopped by the operator by placing it in an OFF status.

.2 From the local panel, placing any pump local HOA selector switch in OFF stops the pump from operating regardless of other conditions.

.3 In AUTO, the pumps automatically shut down in sequence; the LEAD pump continues to run while the LAG pumps shut down in sequence. When inflow falls below 100 ML/d, only the lead pump should remain in operation.

3.3 Adverse Conditions

.1 Low Flows: When the minimum capacity of a single pump exceeds the SE flow, water level in the intake structure will fall. The pump will stop if the interval of low flow is sufficient to decrease the water level to the shut off level of 225.82 m (4.0 m). The pump will restart when the water level rises to 226.37 m (4.55 m).

.2 High flows: When flow exceeds the capacity of each individual pump, water level in the intake structure will rise, and the pumps will start/stop or speed up/slow down in response, as described above in 3.2.3.2.

.3 Extreme flows: When the influent to the Works exceeds the design capacity of the five (5) duty pumps (410 – 430 ML/d), the five (5) pumps will run continuously at the speed required to convey their maximum capacity, and excess flows will be allowed to spill over the PE bypass weir (approximately 150 m upstream of the EGC) directly to the outfall.

.4 One (1) unit out of service: The facility is not designed to allow a pump to be taken out of service at any one time. A shelf spare is provided and any out-of-service unit needs to be removed and the spare installed in its place.

3.4 Complete Pump System Failure

.1 The pumps are supplied with redundant power supplies. In the event of a *localized* catastrophic event that causes the pump station to shut down, *independently of the entire plant*, it will no longer be possible to disinfect. However, flow will still be entering the plant and the pump station and UV system will need to be bypassed.

.2 Due to hydraulic constraints, it is not possible to passively overflow the peak flow through the existing system. Without pumping, the capacity of the single Secondary Conduit falls from 400 ML/d to approximately 275 ML/d.

.3 If the flow is less than 250 ML/d, and the pumps fail, the condition will trigger a signal to restrict plant inflow at the Influent Pumps to 250 ML/d. The overflow weir at the pump intake will allow approximately 250 ML/d to overflow. The hydraulic gradeline in the SE conduit will increase approximately 500 mm, but at this flow and below, the secondary clarifier discharges should remain free.

.4 If the plant flow is greater than 250 ML/d, the Influent Pumps will also be slowed, but the effect on SE flows will not be immediate. The south secondary effluent conduit (SSECon) needs to be opened, and relatively quickly as there is minimal storage available in the SE Conduit system (approx 275,000 L under best conditions). An actuator (independent power source from the UV Pumps) will open the gate automatically (at lower flows the gate will not open automatically, but will open on active intervention of a human operator).

.5 In the event of a plant-wide power failure, the need to bypass is eliminated as no flow is entering the plant due to shut down of the influent pumps.

END OF SECTION

UV BYPASS DESIGN AND OPERATING DESCRIPTION

1. INTRODUCTION

.1 In the event of localized failure of all pumps, the ability to bypass the UV Disinfection Facility and allow the effluent into the outfall is required. Due to restrictions in the modified and existing systems, passive bypass of the full flow is not possible Secondary Effluent (SE) leaves the clarifiers via a pair of rectangular conduits.

.2 The restriction is due to the separation of the SE conduits so that SE flow is confined to the one side only. This is possible only with pumps maintaining an artificially low discharge level at the Effluent Gate Chamber (EGC). With the pumps out of service, the outfall again regains control of the hydraulic gradeline, reducing the secondary conduit capacity from its "assisted" 800 ML/d (400 ML/d per side) to 550 - 575 ML/d (275 ML/d per side).

.3 At 380 to 430 ML/d, the river-independent outfall inlet water level (equivalent to UV effluent channel level) is about 5.6 m, which is higher than the normal operating level of 4.3 to 4.8 m at the pump intake and higher than the maximum invert of a passive overflow weir which could discharge 400 ML/d while maintaining a relatively free flow from of the rectangular secondary clarifiers (approximately 4.6 m). It is therefore not possible to bypass 400 ML/d through the system as proposed by a passive gravity system alone.

.4 A gravity bypass is installed which allows partial functionality, permitting bypasses to occur without intervention up to about the average daily flow of 200 ML/d. If flows increase during a pump bypass, the secondary clarifiers will flood, potentially into the return activated sludge (RAS) channels. To prevent this, the inflow to the secondary treatment process needs to be restricted and the secondary conduit that has been closed off and dedicated to primary effluent bypass will need to be reopened. An automatic gate at the upstream end of the closed-off SE conduit will open to excess flow to pass directly to the outfall.

.5 A flapgate at the exit of the UV gravity bypass channel prevents refluxing of disinfected flows back into the pump intakes when the UV effluent channel water level is higher than 5.6 m (typical at flows on the order of 400 ML/d).

.6 An overflow weir at the pump intake sump of sufficient elevation to be above the minimum high water level (HWL) in the outfall at 200 ML/d (5.0 m). Accounting for headlosses through the flapgate and channel, the minimum crest elevation is 5.3 m. The weir is of sufficient length such that the head over its crest does not cause the water level upstream to increase above the point at which the secondary clarifiers are jeopardized. The weir length matches the length of the bypass overflow box, approximately 18.8 m, which restricts headloss at 200 ML/d to about 160 mm, resulting in a water level at the pump intake chamber of 5.46, which provides approximately 400 mm of freeboard at the secondary clarifier.

.7 A method of restricting the flow into the plant to limit the flow to the capacity of one (1) SE conduit also aids in preventing flooding of the secondary clarifiers. In the event of UV pump failure, the main plant influent pumps' speeds will adjust to limit flow to not more than 250 ML/d.

.8 Restricting inflow may not have an immediate effect on the effluent flow. Gate YG12B (at the Primary Effluent Bypass structure) is fitted with an actuator allowing it to open automatically and relatively expediently when UV bypasses occur.

.9 With Gate YG12B open and the South SE conduit in service, the bypass system could readily accommodate over 400 ML/d without flooding the secondary clarifiers.

.10 The bypass process would proceed generally as follows, provided the river level is at or below 4.6 m at the outfall exit:

- Pump power feed fails and pumps 1 through 5 shut down.
- Water level in pump intake increases in response to above.
- If flow out of the secondary system is less than 250 ML/d, the main influent pumps will receive a signal to ensure that the inflow stays below this limit. If the flow out of the secondary system is more than 250 ML/d, the main influent pumps will receive a signal to slow down. The Gate YG12B will not open automatically, but can be opened remotely by the operator.
- If the flow is in excess of 250 ML/d, slowing the pumps will not have an immediate benefit. In this case, the actuator at Gate YG12B receives signal that disinfection feed pumps are off, and begins to open.
- Water rises past crest of pump intake overflow weir.
- Water begins to fill the bypass channel until water level exceeds the downstream outfall inlet water level, forcing flapgate open.
- If Gate YG12B opens, SE begins to flow down south SE conduit, directly to outfall bypass.
- The secondary clarifiers will not flood while a total effluent flow of approximately 550 ML/d is conveyed during bypass with both SE conduits in service, provided river level is below that at which outfall hydraulics are affected.

2. DESIGN

2.1 Description

.1 SE flows through a channel to a structure where five (5) submersible axial flow propeller pumps are installed in vertical draft tubes. In the event of complete pump failure, effluent level will rise and overflow into a bypass channel

.2 Hydraulic limitations allow only about 250 ML/d to bypass passively under favourable conditions. In the event flows are higher, inflow to the plant will be restricted and Gate YG12B will open to allow use of both sides of the secondary conduit system.

2.2 Design Criteria

.1 Normal HWL at pump intake (380 ML/d): 226.62 m ASL (above sea level) / 4.8 m APD (above plant datum)

.2 Minimum Water Level at Outfall Inlet @ 380 ML/d: 227.42 m ASL / 5.6 m APD

.3 Minimum Water Level at Outfall Inlet @ 250 ML/d: 227.07 m ASL / 5.25 m APD

.4 Minimum Water Level at Outfall Inlet @ 200 ML/d: 227.92 m ASL / 5.1 m APD

.2 If all pumps shut down, the water level at the intake will rise. The water level will eventually rise until it begins to spill over the bypass weir, filling the bypass channel. The bypass level will fill until its water level exerts enough force to open the flapgate against the head exerted by water on the downstream side. At flows up to about 250 ML/d and river level below 5.0 m, the overflow weir should operate under a freefall condition, with the upstream water level at approximately 227.27 (5.45 m APD).

.3 If flows exceed 250 ML/d, the overflow weir will submerge and the upstream channel and SE Conduit water levels will increase. The single conduit should still be able to convey the flow up to about 275 ML/d.

.4 If flows exceed 275 ML/d, the capacity of the single SE conduit will begin to be taxed, and the water level at the secondary clarifier outlets will begin to submerge. With only one (1) SE conduit open, the effect of this flooding will be more profound than presently occurs with two (2) SE conduits in service, in which only the weirs are inundated. With only one (1) SE conduit in service, the WL in the secondary clarifier has potential to overflow the RAS channel, with more serious, long-term impact on the process.

.5 If all five (5) UV influent pumps fail and flows are below 250 ML/d, the following occurs:

- The influent pumps will be slowed to the degree practical (based on existing influent conditions) in an attempt to prevent flow to be bypassed from exceeding 200 to 250 ML/d.
- An alarm will annunciate and Gate YG-12B will remain closed. Manual intervention will be required to open the gate under this condition.

.6 If all five (5) UV influent pumps fail and flows exceed 250 ML/d, the following occurs:

- The influent pumps will be slowed to the degree practical (based on existing influent conditions) in an attempt to decrease flow to be bypassed to 200 to 250 ML/d.
- Gate YG-12B will open to admit effluent into the closed south SE Conduit to alleviate the hydraulic stress on the open north SE Conduit.

END OF SECTION

UV DISINFECTION SYSTEM DESIGN AND OPERATING DESCRIPTION

1. INTRODUCTION

.1 The ultraviolet (UV) equipment is City supplied. The Contractor shall be responsible for supplying, installing, and Commissioning of the UV disinfection system.

.2 This Section provides a summary of the design and operating philosophy for the UV disinfection system. For a detailed description of the control philosophy for the UV equipment, refer to the Shop Drawings provided by Trojan Technologies Inc.

.3 Pumped secondary effluent (SE) flows down a channel and is distributed into the three (3) UV reactor channels for disinfection. The disinfected effluent is directed to the existing outfall, for discharge to the Red River.

2. DESIGN

2.1 Description

.1 The design of the UV disinfection system, including the channels and hydraulics, is based on the Trojan UV4000Plus medium-pressure, high-intensity lamp system.

.2 Under normal operating conditions, SE is pumped to the common channel that feeds the disinfection facility. The flow is split to the three (3) disinfection channels using fixed level weirs (U100-W1, U200-W2, and U300-W3).

.3 The ultrasonic level sensor (U060-LE) upstream of the weirs measures the flow by converting the observed depth to a value for flow according to the appropriate algorithm for the weir. A 4-20 mA output signal from the level sensor is sent to the UV control system. This flow signal is used to dose pace the UV banks.

.4 Stop-logs (U100-SL1, U200-SL2, and U300-SL3) are provided at the head of each channel for isolation of the reactor channels.

.5 A modulating weir gate (U100-WG1, U200-WG2, and U300-WG3) is provided at the outlet of each channel. The weir gates ensure a minimum water level in the channel to maintain lamp submergence. In addition, the weir gate will also be used for isolation purposes when the UV channel is taken out of service.

.6 The UV disinfection system configuration utilizes lamps that are submerged, protected in quartz sleeves, and oriented horizontal and parallel to flow. The lamps are assembled in modules that are grouped in lamp banks. The lamps are located inside an enclosed reactor, with banks installed in series. The controls for the system modulate lamp output in response to the treated flow and the measured UV transmissivity of the wastewater. Six (6) banks are provided (U110-UV1A, U120-UV1B, U210-UV2A, U220-UV2B, U310-UV3A, and U320-UV-3B), two (2) in each channel.

.7 An automatic cleaning mechanism removes lamp scaling by both a mechanical wiping action and chemical cleaning. The mechanism consists of a 50 mm wiping section that slides longitudinally along the lamp sheath. A cleaning solution is placed inside the wiping section. The cleaning process can proceed while the system is in operation, only marginally affecting disinfection efficiency. The cleaning system is initiated based on either a detected decrease in UV intensity or a timer. The cleaning system can also be activated manually.

.8 The automatic cleaning system does not remove algae, slime, debris etc. from the lamp heads. Regular removal of the lamps is required to manually remove this material from the lamp heads. Regular drainage of the channels is also required to remove algae and slimes from the channel and reactor walls.

.9 It is critical that the water level not fall below the top of the lamps because of the heat that the lamps generate. The weir gate at the outlet of each UV channel is modulated to so that the water level remains above the minimum level required to ensure lamp submergence. An ultrasonic level meter (U170-LE, U270-LE, and U370-LE) reads the water level in each channel. Should water levels fall below the minimum set level, the lamps are automatically disabled. Low-level switches are provided in each channel (U120-LSL, U220-LSL, U320-LSL).

.10 The disinfection channels will disinfect the peak flow of 380 ML/d, but are capable of hydraulically passing 430 ML/d. In the event of downstream high water levels (HWLs), the UV equipment is shut down. A high-level switch (U110-LSH, U210-LSH, U310-LSH) is provided in each channel. The lamp modules should be raised out of the water if the water level approaches the underside of the ballasts.

.11 A lifting mechanism (electric winch) assists in the raising of UV lamp modules for inspection and maintenance or in the event of HWLs.

.12 After disinfection, effluent flows from the UV facility flows through a 3000 mm wide channel to the existing 2290 mm diameter outfall pipe.

2.2 Design Criteria

.1 The UV facility is designed to disinfect up to 380 ML/d but is capable of hydraulically passing 430 ML/d. The design annual average flow is 221 ML/d.

.2 Although higher TSS concentrations have been experienced historically, the design peak TSS limit is 30 mg/L, which is expected to be the limit specified by Manitoba Conservation in the licence. The design average TSS concentration is 21 mg/L.

.3 The design minimum UV transmittance (UVt) is 30%.

.4 The facility is designed to produce an effluent with an *E.coli* concentration of 200 MPN/100mL, monitored as a monthly geometric mean of

.5 Extensive collimated beam testing of the effluent facilitated the estimation of the design UV dosage. The design dosage is 35 mWs/cm^2 at 380 ML/d, 30% UVt, and at the end of lamp

life. This dosage a reasonable safety factor to accommodate small system malfunctions and statistical uncertainties.

.6 Six banks of lamps are required. Each bank contains seven (7) modules of 24 lamps. The total number of lamps required for the system is 1,008.

2.3 Design Data

.1 UV Equipment

Description	Units	Design Value
Disinfection Capacity	ML/d	380
Hydraulic Capacity	ML/d	430
UVT Transmittance	%	30
Design TSS (mg/L)	mg/L	30
E.coli	MPN/100 mL	200
Design UV Dose	mWs/cm^2	35
Number of Channels		3
Number of Banks per Channel		2
Number of UV Modules per Bank		7
Number of UV Lamps per Module		24
Total Number of UV Lamps		1,008
Minimum Rated Life of UV Lamps		5,000
Power per Lamp at Peak Power Setting	kW	3.2

2.4 Arrangement

.1 The disinfection facility is located east of the Administration Building.

.2 The UV disinfection channels are orientated east-west, parallel to the existing outfall pipe.

.3 The invert of the UV disinfection channel is at an elevation of 228.178 m. The operating floor of the facility is at an elevation of 232.238 m.

2.5 Other Disciplines

.1 Structural/Building Services

.1 The UV channels should be covered with a removable decking to allow for the removal of the lamp modules from the channel. A small hatch downstream of the UV equipment is required for sampling of the disinfected flow from each channel. A hatch is also required upstream of the reactors for sampling purposes.

.2 A building is required to house the electrical and mechanical equipment.

.2 Mechanical

.1 Heating, ventilation, and air conditioning (HVAC) are required.

.3 Electrical

.1 The electrical room and electrical service located adjacent to the UV disinfection channel is sized for the major items of equipment installed. The major power draw is for the lamps which have a maximum demand of 3,226 kW. Other power demands include the system control centre (SCC), the hydraulic service centres (HSC) and the module removal mechanisms (MRM).

.2 The Power Distribution Centre (PDC), HSC and MRM are all located on top of the UV reactors.

3. OPERATING DESCRIPTIONS

3.1 General

.1 The UV control system has a programmable logic controller (PLC), which continuously monitors and controls the UV system's functions. Custom electronics, pressure switches and water level sensors provide the PLC with the necessary indications of system parameters.

.2 Complete control and monitoring of the entire UV disinfection system is accomplished through a touch screen interface.

.3 The PLC based control system communicates to the plant Bailey Distributed Control System (DCS). Data to be exchanged will include operational status and alarms of the UV system and monitoring of effluent flow rate and channel levels. The ultrasonic level meter located at upstream of the weirs at the head of the channels provides a flow signal for the UV disinfection system. An ultrasonic level meter located in the UV channel signals the effluent level in the channel to the PLC.

.4 An automatic dose paced control is provided by the UV equipment supplier. The control system modulates lamp performance to maintain desired UV dose, proportional to flow and UV demand, while conserving power. Commands to turn UV banks on and off are retentive, such that operating banks remain on, and non-energized banks remain off, in the event of a PLC failure, and following restoration of power after a power failure.

.5 Each UV bank is to be controlled from a communications board, which controls and monitors the bank. This communications board is located within a PDC into which the main power supply wire is fed. All communications to and from the PDCs originate from the PLC via an RS422 serial link. All lamp, ballast and bank status signals are communicated to the PLC via this serial link.

3.2 Control Devices

Description	Location	Number	Function
HOA Switch	Local	6	Turn UV system Bank control from UV Equipment (AUTO) to OFF to local (HAND).
HOA Switch	Local	6	Turn UV system wiper control from UV Equipment (AUTO) to OFF to local (HAND).
Sequence/Extend/Retract Switch	Local	6	Operate the wiper in automatic sequence, or Extend or Retract the wiper in hand.
L/R Switch	Local	3	Turn UV channel weir control from manual (LOCAL) to UV Equipment (REMOTE).
Open/Close	Local	3	Raise or lower the UV channel weir.

3.3 Normal

.1 Automatic (local HOA selector switches in AUTO and local L/R switches in REMOTE)

.1 The stop-logs (U100-SL1, U200-SL2, and U300-SL3) are removed from the head of the channels to allow flow of effluent through the disinfection channels.

.2 The disinfection channel weir gates (U100-WG1, U200-WG2, and U300-WG3) are modulated to ensure that minimum water levels maintain lamp submergence.

.3 During normal operation, The Bank Switch and the first Wiper switch must be in the AUTO position. All power switches must be ON and all alarms must be clear

.4 UV dosage (or power output of the banks) is controlled by the PLC and the banks are cycle on and off as required. The output is modulated based on a flow signal from the ultrasonic level meter (U060-LE), and the UV transmittance value, manually entered into the control system by the operator.

.5 An automatic and integrated lamp cleaning system ensures that the lamps are cleaned on a periodic basis. The cleaning systems use both mechanical wiping and chemical action to descale the lamp sleeves. When the Wiper switch is in the AUTO mode, the cleaning cycle is activated from the control system on a timer. The cleaning frequency is field adjustable from one (1) hour to one (1) month. The cleaning cycle can be initiated manually at the operator interface.

.2 Manual (Local HOA selector switch in HAND)

.1 In HAND, the bank power can be set from the Manual Power Settings screen.

.2 In HAND, the wipers can either be extended or retracted to simulate a cleaning cycle (Wiper HOA placed in OFF or HAND, Wiper L/R switch in LOCAL and Wiper switch in either EXTEND or RETRACT).

.3 Startup

.1 Manually remove the stop-logs from the head of each channel.

.2 Ensure that the Bank and Wiper switches on all of the PDCs are in the OFF position.

.3 Ensure that all of the individual module breakers (EPDs) in the PDCs are turned ON.

.4 Ensure that all of the other breakers in the UV system are ON.

.5 Switch on the main power to the UV system.

.6 Make sure that none of the EPDs trip. If they do, investigate the affected module for water intrusion or other fault.

.7 Wait ten (10) minutes for the Time-On Timers to expire.

.8 Go to the Cooling System Status screen on the Operator Interface and ensure that the pump is running and that the pressure is normal.

.9 Turn the Bank and Wiper switches on all of the PDCs to AUTO.

.10 Go to the Bank Control screens on the Operator Interface and set all of the banks to AUTO.

.11 Go to the Wiper Control screen on the Operator Interface and set all of the banks to AUTO.

.4 Shutdown Operation - Maintenance

If a bank must be shut down for maintenance, it is preferable to do this at a low demand time when only one bank of lamps is required.

.1 Ensure that the other bank in the channel is in full AUTO control (Switches on the PDCs in REMOTE and Bank Control and Wiper Control on the Operator Interface in AUTO)

.2 Set the Bank Control and Wiper Control on the Operator Interface for the affected bank to OFF. Turn the Bank and Wiper switches on the PDC for the affected bank to OFF.

.3 Although each module has a mercury switch that will turn off the power to the module if it is removed from the channel, this must NOT be relied on for maintenance. Turn off all of the switches for the affected bank before removing modules from the channel.

.5 Shutdown Operation – Channel Cleaning

To shut down the system temporarily, for channel cleaning.

.1 On the Bank Control screen of the Operator Interface, set the appropriate banks to REMOTE-OFF

.2 Turn off all switches on the PDCs.

.3 Turn off all power to the PDCs.

.4 Isolate the channel using the stop-logs and raising the weir.

.6 Drain the UV channel.

.1 Clean the channel.

3.4 Adverse Conditions

.1 When a HWL is detected by the ultrasonic level meter in the UV channel, an alarm is annunciated but the affected banks are not shut down.

.1 When a low water level (LWL) in the channel is detected, an alarm is annunciated and the affected banks are shut down after 15 seconds. The banks are interlocked so that they cannot be started if a LWL exists.

END OF SECTION

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DIVISION 15

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DIVISION 15

Reviewed and Approved

Date

1. GENERAL

1.1 Intent

.1 Provide complete, fully tested and operational mechanical systems to meet the requirements described herein and in complete accord with applicable codes and ordinances.

.2 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material and installation quality and are not detailed installation instructions.

.3 Follow Manufacturers' recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.

.4 Install equipment generally in locations and routes shown. Run piping and ductwork close to building structure, parallel to building lines to maximise head room and with minimum interference with other services and free space. Remove and replace improperly installed equipment to satisfaction of the Contract Administrator at no extra cost.

.5 Install equipment to provide access and ease of maintenance.

.6 Connect to equipment specified in other Sections and to equipment supplied and installed by other Contractors or by the City of Winnipeg (City). Uncrate equipment, move in place and install complete; start-up and test.

.7 Install control valves, control dampers, thermal wells, and other devices on piping and ducts, furnished by Controls Contractor.

.8 Furnish a written guarantee stating that all Work executed in this Contract will be free from defective workmanship and materials for a period of one (1) year from the date of Substantial Performance. The Contractor shall, at his own expense, repair and replace any Work which fails or becomes defective during the term of the guarantee/warranty, providing such Work is not due to improper usage. The period of guarantee specified shall not in any way supplant any other guarantees of a longer period but shall be binding on Work not otherwise covered.

.9 If the equipment is used during construction, the guarantee or guarantee period shall not be shortened or altered.

.10 'Provide' shall mean; 'supply and install'.

1.2 Co-ordination of Work

.1 Co-operate and co-ordinate with other trades on the project.

.2 Make reference to electrical, mechanical, structural and architectural Drawings when setting out Work. Consult with respective Divisions in setting out locations for ductwork,

equipment, and piping, so that conflicts are avoided and symmetrical even spacing is maintained. Jointly resolve all conflicts on-site before fabricating or installing any materials or equipment.

.3 Where dimensional details are required, coordinate with the applicable architectural and structural Drawings.

.4 Full size and detailed Drawings shall take precedence over scale measurements from Drawings. Drawings shall take precedence over Specifications.

.5 Any areas indicated as space for future materials or equipment shall be left clear.

1.3 Permits

.1 All Work shall comply with provincial, municipal, bylaws and authorities having jurisdiction.

.2 Obtain all permits and pay all fees applicable to the Work.

.3 Contractor shall arrange for inspections of the Work by the authorities having jurisdiction and shall provide certificates indicating Final Approval.

1.4 Examination of Site

.1 Before submitting tender, visit and examine the Site and note all characteristics and features affecting the Work. No allowances will be made for any difficulties encountered or any expenses incurred because of any conditions of the Site or item existing thereon, which is visible or known to exist at the time of Tender.

1.5 Quality of Work

.1 All Work shall be by qualified tradesmen with valid Provincial Trade Qualification Certificates. Spot checks will be made by the Contract Administrator.

.2 Work which does not conform to standards accepted by the Contract Administrator and the trade may be rejected by the Contract Administrator. The Contractor shall redo rejected Work to the accepted standard at no cost to the City.

1.6 Metric Conversion

.1 All units in this Division are expressed in SI units.

.2 Submit all Shop Drawings and maintenance manuals in SI units.

.3 On all submittals (Shop Drawings etc.) use the same SI units as stated in the Specification.

.4 Equivalent Nominal Diameters of Pipes - Metric and Imperial:

.1 Where pipes are specified with metric dimensions and Imperial sized pipes are available, provide equivalent nominal Imperial sized pipe as indicated in the table, and provide at no extra cost adapters to ensure compatible connections to all metric sized fittings, equipment and piping.

.2 When Canadian Standards Association (CSA) approved SI Metric pipes are provided, the Contractor shall provide at no extra cost adapters to ensure compatible connections between the SI Metric pipes and all new and existing pipes, fittings, and equipment.

mm (inches) (NPS)	mm (inches) (NPS)	mm (inches) (NPS)
3 (1/8)	50 (2)	300 (12)
6 (1/4)	65 (2-1/2)	375 (15)
10 (3/8)	75 (3)	450 (18)
15 (1/2)	100 (4)	500 (20)
20 (3/4)	125 (5)	600 (24)
25 (1)	150 (6)	750 (30)
30 (1-1/4)	200 (8)	
40 (1-1/2)	250 (10)	

.5 Metric Duct Sizes:

.1 The Metric duct sizes are expressed as 25 mm = 1 inch.

.6 Not applicable.

1.7 Alternate Materials and Equipment

.1 The price submitted for this Contract shall be based on the use of materials and equipment as specified or as contained within the Acceptable Manufacturers List.

.2 Requests for approval for Tendering purposes of equivalent materials or equipment shall be submitted to the Contract Administrator no later than seven (7) working days prior to the closing date of Tender for mechanical trade, complete with all applicable technical data, including performance curves and physical details. Approval of requests shall only be given by Addendum.

.3 The Contractor shall, in his quotation, indicate the degree of approval obtained from the Contract Administrator. In the event that the Product has been approved as "Alternate Only", this shall be stated in the quotation, and the Contractor shall bear any and all costs for design/system modifications to accommodate the “alternate” equipment.

.4 Approved equivalents and/or alternatives to specified Products shall be equal to the specified Product in every respect, operate as intended, meet the space, capacity, and noise requirements outlined.

.5 The Contractor shall be fully responsible for any additional Work or materials required by the trades or other Contractors to accommodate use of other than specified materials or equipment. Extras will not be approved to cover such Work.

1.8 Drawings and Specifications

.1 Drawings and Specifications are complementary each to the other, and what is called for by one shall be binding as if called for by both.

.2 Should any discrepancy appear between Drawings and Specifications which leaves the Contractor in doubt as to the true intent and meaning of the plans and Specifications, obtain a ruling from the Contract Administrator, before submitting a tender. If this is not done, it will be assumed that the most expensive alternate had been included.

.3 Examine all Contract Documents, including all Drawings and Specifications, and Work of other trades to ensure that Work is satisfactorily carried out without changes to building.

1.9 Shop Drawings

.1 Provide six (6) printed copies, for all scheduled equipment and as specified in specific equipment Sections of this Specification.

.2 Identify materials and equipment by Manufacturer, trade name and model number. Include copies of applicable brochure or catalogue material. Do not assume applicable catalogues are available in the Contract Administrator's office. Maintenance and operating manuals are not suitable submittal material.

.3 Clearly mark submittal material using arrows, underlining or circling to show differences from specified, e.g. ratings, capacities and options being proposed. Cross out non-applicable material. Specifically note on the submittal specified features such as special tank linings, pumps seals materials or painting.

.4 Include weights, dimensional, and technical data sufficient to check if equipment meets requirements. Include wiring, piping, and service connection data and motor sizes. Provide centre of gravity diagrams for the use of the seismic consultant.

.5 Installed materials and equipment shall meet specified requirements regardless of whether or not Shop Drawings are reviewed by the Contract Administrator.

.6 Do not order equipment or material until the Contract Administrator has reviewed and returned Shop Drawings.

.7 Prior to submission to the Contract Administrator, the Contractor shall review all Shop Drawings. By this review, the Contractor certifies that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data, and certifies that he has checked and co-ordinated each Shop Drawings with the requirements of the Work of the Contract Documents. The Contractor's review of each Shop

Drawing shall be indicated by stamp, date and signature of the Contractor's designated project manager.

.8 Retain one (1) copy of Shop Drawings on-site for review.

1.10 Salvage

.1 Remove from Site all equipment, ducting or piping which is no longer required because of Work under this Contract.

.2 Turnover to and deliver to the City's storage area all items which have been determined to have salvage value and has been removed due to the Work.

1.11 Cutting, Patching and Coring

.1 Provide holes and sleeves, cutting and fitting required for mechanical Work. Relocate improperly located holes and sleeves.

.2 Drill for expansion bolts, hanger rods, brackets, and supports.

.3 Obtain written approval from the Contract Administrator before cutting or burning structural members.

.4 Provide openings and holes required in precast members for mechanical Work. Cast holes 100 mm (4 in.) or larger in diameter. Field-cut smaller than 100 mm (4 in.).

.5 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective Section.

1.12 Excavation and Backfill

.1 Refer to requirements of Division 2.

.2 Provide all excavating to facilitate installation of the mechanical Work, including shoring, pumping, 150 mm (6 in.) compacted sand bedding under and first 300 mm (12 in.) of compacted sand over piping and ducting.

1.13 Installation of Equipment

.1 Pipe all equipment drains to building drains.

.2 Unions and flanges shall be provided in piping or ductwork to permit easy removal of equipment.

.3 Maintain permanent access to equipment for maintenance.

1.14 Fire-Stopping

.1 Fire-stop all pipe, duct, conduit and wire penetrations through floors and walls, designated as fire and/or smoke separations. The Contractor is required to co-ordinate with the architectural Drawings to contractual rated wall types and installation details.

.2 Fire-stopping materials to meet Underwriters Laboratories of Canada (ULC) CAN 2S115. Acceptable Materials: by "Tremco" or "National Firestopping".

.3 Preparation of surfaces and installation of fire-stopping materials shall be carried out as per Manufacturer's instructions.

1.15 Connections to Existing Services

.1 Maintain liaison with the City and provide a schedule to interrupt, re-route or connect to water, sewer, heating, or gas systems, with minimum interruption of services.

.2 Major services shall not be interrupted before all preparatory Work is completed and all required materials are on-site. Provide a minimum of forty-eight (48) hours notice for all service shutdown.

.3 Interruptions and shutdowns of existing services shall be by the building/plant maintenance staff.

1.16 Equipment and Materials

.1 Materials and equipment installed shall be new, full weight and of quality specified.

.2 Each major component of equipment shall bear Manufacturer’s name, address, catalogue and serial number in a conspicuous place.

.3 Where two (2) or more Products of the same type are required, Products shall be of the same Manufacturer.

.4 Make known in writing to the Contract Administrator ten (10) days prior to the Tender closing date any materials specified that are required to complete the Work which are not currently available or will not be available for use as called for herein. Failing to do so, it will be assumed that the most expensive alternate has been included in the Tender price.

1.17 Equipment Protection and Clean-Up

.1 Protect equipment and materials in storage on-site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.

.2 Protect equipment with polyethylene covers and crates.

.3 Operate, drain and flush out unsealed bearings and refill with new change of oil, before final acceptance.

.4 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign substances.

.5 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.

.6 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.18 Electrical Motors

.1 Supply mechanical equipment complete with electrical motors.

.2 Provide motors designed, manufactured, and tested in accordance with the latest edition of the following codes and standards: National Electrical Manufacturers Association (NEMA), Electrical & Electronic Manufacturer's Association of Canada (EEMAC), Canadian Standards Assoication (CSA), Canadian Electrical Code (CEC) Part 1, Institute of Electrical and Electronic Engineers (IEEE) and American National Standards Institute (ANSI). All motors to be CSA labelled. All motors to be approved for use in the designated area classification by the Provincial Electrical Protection Branch. All motors intended for use with a variable speed drive (VSD) [variance frequency drive (VFD)] shall be inverter only rated.

.3 Unless specified otherwise, provide motors designed for full voltage starting, EEMAC Design B. Motors driving high torque or high inertia loads may be EEMAC Design C or D.

.4 Provide motors rated for continuous duty with 1.15 service factor unless specified otherwise in the driven equipment Specifications. Provide all motors with thermal overload protection.

.5 Motors less than ½ hp shall be 120 V, 60 Hz, 1 phase. Motors ½ hp and larger shall be 3 phase at the indicated voltage.

.6 All motors shall be 1800 rpm unless otherwise indicated.

.7 Provide motors with grease or oil lubricated anti-friction type ball or roller bearings.

.8 Provide motors designed with Class B insulation; Class F insulation for totally enclosed motors.

.9 Refer to electrical Specifications, Division 16, for voltage, frequency, and phase data. This shall take precedence over any reference in Division 15.

.10 Where motor power is stated in watts or kilowatts, nominal motor horsepower multiplied by 746 or 0.746 respectively, has been used as the conversion factor.

.11 Minimum certified motor efficiency shall be as outlined in Manitoba Hydro's latest high efficiency motor incentives program, or the following table, whichever indicates the higher minimum efficiency.

MINIMUM EFFICIENCY (%) *

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1	75.5	82.5	80.0	74.0
1.5	82.5	84.0	85.5	77.0
2	84.0	84.0	86.5	82.5
3	85.5	87.5	87.5	84.0
5	87.5	87.5	87.5	85.5
7.5	88.5	89.5	89.5	85.5
10	89.5	89.5	89.5	88.5
15	90.2	91.0	90.2	88.5
20	90.2	91.0	90.2	89.5
25	90.5	91.7	91.3	89.6
30	90.8	91.9	91.4	90.7
40	91.4	92.5	92.3	90.6
50	91.9	92.7	92.3	91.3
60	92.4	93.2	92.9	91.6
75	92.5	93.5	93.1	92.8
100	93.0	93.7	93.5	92.7
125	93.6	93.9	93.6	93.4
150	93.8	94.3	94.2	93.4
200	94.3	94.5	94.6	93.9
250	95.0	95.0	95.0	95.0
300	95.0	95.0	95.0	95.0
400	95.0	95.0	95.0	95.0
500	95.0	95.0	95.0	95.0

(*) As defined in CSA C390 or IEEE 112B Nominal Standards

1.19 Access Doors

.1 Provide access doors for maintenance or adjustment purposes for all mechanical system components including:

- Valves;
- Volume and splitter dampers;
- Fire dampers;
- Cleanouts and traps;
- Controls, coils and terminal units;
- Expansion joints.

- Filters
- Strainers

.2 Steel frame access panel with stainless steel piano-type hinge, channel reinforced steel door panel, three "Symmons" fasteners per door. Door panel recessed to receive ceiling or wall material to give finished appearance showing only hinge and fasteners. Provide acoustic gasket between door panel perimeter and steel frame. Rated access doors shall be UL-listed.

.3 Mark removable ceiling tiles used for access with colour coded dots.

.4 Sizes to be 200 mm x 200 mm (8 in. x 8 in.) for cleanout, 300 mm x 300 mm (12 in. x 12 in.) for hand 600 mm x 600 mm (24 in. x 24 in.) for body access minimum.

.5 Provide Underwriters Laboratories of Canada (ULC) listed fire rated access doors installed in rated wall and ceilings.

1.20 Miscellaneous Metals

.1 Provide all necessary miscellaneous to hang or support materials, equipment and provide access for Work under this Contract.

.2 All miscellaneous metals shall be prime painted.

.3 Miscellaneous metals shall include but not limited to:

.1 Hangers for equipment, piping and ductwork.

.2 Support for equipment.

.3 Access platforms and catwalks.

1.21 Escutcheon and Plates

.1 Provide escutcheon and plates on piping and ductwork passing through finished walls, floors and ceilings.

.2 Escutcheons shall be split type, stainless or chrome plated steel.

1.22 Painting and Identification

.1 Co-ordinate colour coding of piping and equipment with Work of Division 9.

.2 Colour code mechanical equipment, piping and exposed ductwork. Refer to colour schedule at end of this Section.

.3 Legend and direction of flow arrows shall consist of adhesive backed labels, yellow colour, with minimum 20 mm (3/4 in.) high black lettering equal to Brady System B-500, vinyl cloth labels for non-insulated surfaces; and Brady B 946 for insulated surfaces.

.4 Identify piping with labels, colour bands, and flow arrows. Provide identification at 15 m (50 ft) maximum intervals, before and after pipes pass through walls, at all sides of tees, behind access doors and in equipment rooms as required.

.5 Apply colour bands at both ends of the label with primary colour bands used to secure both ends of individual labels. Refer to colour schedule at end of this Section.

.6 Provide 20 mm (3/4 in.) diameter brass, with metal photo black numbers, or white lamacoid with black engraved numbers, secured to valve stem with key chain.

.7 Provide neat, typewritten directories, giving valve number, services and location. Frame one copy under glass for wall mounting as directed, second copy to be forwarded to City. Include copies in operation and maintenance (O&M) Manuals.

.8 Tag automatic controls, instruments and relays and match/key to control Shop Drawing identification numbers. Tag all equipment and control panels.

.9 Identify electric starting switches, thermostats controlling motors, remote push button stations, and controls equipment supplied under this Division with lamacoid plates having 6 mm (1/4 in.) minimum letter size. Identification to state equipment controlled.

.10 Identify the usage of duct access panels with self adhesive Brady stick-on coloured labels. Apply labels conforming to the following schedule.

	Color	Letters
Cleaning and service access	yellow	C.A.
Controls, including heat sensors	black	C.
Dampers (backdraft, balance & control)	blue	D.
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

Note: Provide black lettering for yellow or white background, white for all other colours.

.11 Identify the location of the following items of equipment which are concealed above a ceiling with Avery "Data Dots". Place identification dots on the access panel. The colours shall conform to the following schedule:

Concealed equipment and cleaning access	yellow
Control equipment, including control dampers and valves, and heat sensors	black
Fire, smoke, and sprinkler equipment including dampers	red
Pipe mounted equipment with the exception of fire, smoke, sprinkler and control equipment	green

Balancing Dampers blue

When T-bar ceilings are installed, adhere "Data Dots" on T-bar framing adjacent to panel to be removed.

1.23 Colour Coding Schedule

.1 Colour numbers are called for in Canadian Government Specification No. 5-GP-1a. Colours assigned from CGSB 1-GP-12c for colour code identification.

MECHANICAL PRIMARY COLOURS FOR PIPE LINES/EQUIPMENT

1.	Yellow	-	505-102
2.	Light Blue	-	502-106
3.	Green	-	503-107
4.	Orange	-	508-102
5.	Brown	-	504-103
6.	Red	-	509-102
7.	White	-	513-101
8.	Aluminum	-	515-101
9.	Purple	-	501-101
10.	Grey	-	501-107

SECONDARY COLOURS FOR BANDS

1.	Red	-	509-102
2.	Orange	-	508-102
3.	Blue	-	502-106

BANDING

1. Red - to indicate extremely hazardous material
2. Orange - to indicate mildly hazardous material
3. Blue - to indicate non-hazardous material

.2 Identification Symbols and Colour for Piping

	Pipe Colour	Stripe Colour	Symbol
Chilled Glycol Return	Green	Orange	Ch Glycol R
Chilled Water Supp.	Green	Orange	Ch Glycol S
Compressed Air	White	None	kPa Air
Condenser Glycol Return	Green	Orange	Cond Glycol R
Condenser Glycol Supply	Green	Orange	Cond Glycol S
Domestic Cold Water	Light Blue	None	Dom Cold Wat
Domestic Hot Water	Green	Orange	Dom Hot Wat
Domestic Hot Water	Green	Blue	Dom Hot Wat R
Drains	Aluminum	Red/Orange	Drain
Effluent Return	Green	Orange	Effluent R
Effluent Return	Green	Orange	Effluent S
Glycol Heating Return	Green	Orange	Glycol Heat R
Glycol Heating Supply	Green	Orange	Glycol Heat S
Vent	Aluminum	Red/Orange	Vent

.3 Identification Symbols and Colours for Equipment:

	Pipe Colour	Stripe Colour	Symbol
Fan Guards - Motor Guards	Red Machinery Enamel		
Hangers, Brackets, Hanger Rods	Black Machinery Enamel		
Heat Exchangers	Green	Orange	None
Heat Pumps - Chillers	Green	Red	None
Heat Pumps - Heating	Green	Red	None
Pumps - Regular	Aluminum	None	None
Supports	Black	None	None
Tanks – Hot Water (Insulated)	Green	Orange	None
Valves Uninsulated	High Heat Aluminum		

.4 Mechanical Control Systems

.1 Conduit pull boxes, terminal boxes and junction boxes - GREY Covers - GREY with black 'C'.

.2 Main and secondary control panels, factory finish acceptable - control Contractor to install company label to identify.

.5 Ductwork

All ductwork in mechanical rooms to be identified as follows, complete with directional arrows:

Return Air	R.A.
Supply Air	S.A.
Outside Air	O.A.
Mixed Air	M.A.
Combustion Air	Comb.Air
Relief Air	Relief Air
Exhaust Air	Exh.Air.

1.24 Temporary Heat

.1 Do not use the permanent system for temporary heating purposes without written permission from the Contract Administrator.

.2 Thoroughly clean and overhaul permanent equipment used during the Construction Period, replace worn or damaged parts before final inspection.

.3 Use of permanent systems for temporary heat shall not modify terms of Warranty.

.4 Operate heating systems under conditions which ensure no temporary or permanent damage. Operate with proper safety devices and controls installed and fully operational. Operate systems only with treated water as specified.

.5 Air systems shall not be used for temporary heating.

.6 When permanent systems are used for temporary heat, provide alarm indicating system failure. Connect alarm to independent alarm company system.

.7 Where pumps are used for temporary heating, replace mechanical seals, regardless of condition, with new mechanical seals.

1.25 Temporary or Trial Usage

.1 Temporary or trial usage by the City or Contract Administrator of mechanical equipment supplied under Contract shall not represent acceptance.

.2 Repair or replace permanent equipment used temporarily.

.3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

.4 Avoid thermal shock to heating system by co-ordination with the City during planning, construction and operation of temporary heating system.

.5 Return condensate to the heating plant. Meter equipment is not required.

1.26 Substantial and Total Performance

.1 Prior to requesting an inspection for Substantial Performance, provide a complete list of items which are deficient.

.2 The Contractor shall ensure that all mechanical systems are ready for testing a minimum of eight (8) weeks in advance of the projected completion date to allow for completion of distributed control system (DCS) programming by City and all Commissioning activities.

.3 A certificate of Substantial Performance will not be granted unless the following items are completed:

.1 Heating air conditioning, plumbing and fire protection systems have been commissioned and are capable of operation with alarm controls functional and automatic controls in operation. Commissioning checklists must be submitted prior to the request by the Contractor to have a substantial completion inspection.

.2 The necessary tests on equipment and systems including those required by authorities have been completed with certificates of approval.

.3 Air and water systems have been balanced with draft report submitted to Contract Administrator.

.4 Valve tagging and equipment identification is complete.

.5 Warranty forms have been mailed to the Manufacturer. Provide copy of original warranty for equipment which has warranty period longer than one (1) year.

.6 Systems have been chemically cleaned. Flush and initiate water treatment. Provide report from Manufacturer's Representative to confirm status of treatment.

.7 Draft O&M Manuals have been submitted.

.8 Operating and Maintenance demonstrations have been provided to the City.

.9 Written inspection report by Manufacturer’s Representative has been submitted for noise and vibration control devices and flexible connections.

.10 Record Drawings have been submitted.

.11 Fan plenums have been cleaned, and temporary filters have been replaced with permanent filters.

.12 All previously identified deficiencies have been corrected.

.4 The following shall be an outline checklist of the minimum requirements to be met by the Contractor prior to the Contract Administrators' Substantial Performance by the Contractor.

Inspection:

- ☐ Complete Commissioning Checklists
- ☐ Final Plumbing Inspection Certificate from local plumbing inspector
- ☐ Final Backflow Prevention test reports for all backflow devices
- ☐ Controls Commissioning, Checklist and 15 day trend logs for all major equipment (AHU's, Chiller/Boiler Plants, etc.)
- ☐ Fire alarm test certificate (via DIV.16)
- ☐ Fire stopping and Fire Damper test letter
- ☐ Vibration isolation supplier's inspection report
- ☐ Chemical Treatment supplies final inspection and test certificate
- ☐ Potable water main's flushing and chlorination test certificate
- ☐ Sound level tests reports (as required)
- ☐ Major equipment – suppliers start-up test sheets and letters certifying start up. (boilers, chillers, packaged equipment)
- ☐ Final As-Built Drawings ready for review
- ☐ Maintenance and operation manuals, ready for review

.5 Prior to Total Performance Inspection provide declaration in writing that deficiencies noted at time of Substantial Performance inspection have been corrected and the following items completed prior to the Total Performance inspection:

.1 Submit find air and water balance reports.

.2 Submit final operating and maintenance manuals.

.3 Complete final calibration.

.6 The Contract Administrator shall provide one (1) visitation for the purpose of total performance inspection. Subsequent visitations if required shall be at the expense of the Contractor.

.7 The Contractor shall provide qualified personnel in appropriate numbers to operate the facility until substantial performance is declared.

1.27 Acceptable Manufacturers

.1 The following listed Manufacturers are acceptable for their ability to meet the general design intent, quality and performance characteristics of the specified Product. The list does not endorse the acceptability of all Products available from the listed Manufacturers/Suppliers.

.2 It remains the responsibility of the Contractor to ensure the Products supplied are equal to the specified Products in every respect, operate as intended, and meet the performance Specifications and physical dimensions of the specified Product.

.3 The Contractor shall be fully responsible for any additional Work or materials, to accommodate the use of equipment from the acceptable Manufacturers and Suppliers list.

.4 Submit within fourteen (14) days of Contract award a copy of the list underlining the name of the Manufacturer whose price was carried in the Tender. If no Manufacturers' names are submitted, it will be assumed that the price carried in the Tender was that of the specified Manufacturer or where the specified Product is generic, the first acceptable Manufacturer listed for each item and equipment.

.5 List of acceptable Manufacturers:

• Access Doors	Maxam, Acudor, Milcor, Can.Aqua, Mifab
• Actuators - Dampers	Belimo, Johnson, Honeywell *(All actuators supplied for control components must be by same Manufacturer).*
• Air Handling Units – Electrical Room	Haakon, Scott Springfield, Racan
• Air Handling Units – Process Room	Carrier, McQuay, Trane, York
• Air Separators, Relief Valves	Armstrong, Bell & Gossett, Taco
• Air Terminals - Grilles Registers, Diffusers	E.H. Price, Titus, Nailor
• Air Vents	Hoffman, Maid-O-Mist, Taco
• Backdraft Dampers	Airolite, Vent-Aire, Penn, T.A. Morrison
• Backflow Preventers	Febco, Watts, Hersey, Singer, Ames
• Boilers - Electric	Super Hot, CCI Thermal
• Coils - Heating and Cooling	Trane, Aerofin, Engineered Air, McQuay
• Dampers - Control, Backdraft	Ruskin, Tamco
• Domestic Water Heaters - Electric	Jetglas, Aerco, AO Smith, Ruud-Rheem,

	State
• Drains - Floor, Roof, Cleanouts Trap Primers, Water Hammer Arrestors	Zurn, Ancon, PPP, J.R. Smith
• Expansion Compensators	Flexonics, Tube Turn, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Expansion Joints	Flexonics, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Eye Wash Fountains	Western, Haws
• Fan Coil Units (low profile)	McQuay, Trane, Engineered Air
• Fans – Centrifugal Roof Exhausters	Penn, Greenheck, Cook
• Fans – Direct Drive Inline Centrifugal	Penn, Greenheck, Cook
• Fans - Centrifugal	Buffalo, Twin City, Trane, Chicago, Barry Blower, Northern
• Filters	Cambridge, AAF, Pacific, FARR
• Fire Dampers	Controlled Air, Ruskin, Canadian Advanced Air, Maxam, Nailor
• Flexible Connectors - Ducting	Thermaflex, G.I. Industries Type IHP
• Flexible Connectors - Piping	Flexonics, Tube Turn, Atlantic, Hyspan, Hydroflex, Metraflex, United Flexible, Mason
• Gauges - Air	Dwyer, Magnehelic
• Gauges - OWG Pressure	Trerice, Marsh, Ashcroft, Weiss
• Grooved Mechanical Pipe Joints	Victaulic, Shurjoint, Groove-lok (only where permitted)
• Heat Exchangers - Shell and Tube	Armstrong, Taco, Bell & Gossett
• Heat Pumps	Ice Kube, FHP Industries, McQuay, Trane, Climate Master
• Hose Bibbs	Jenkins, Dahl, Crane, Toyo, Mifab
• Insulation - Piping and Duct	Fibreglass Canada, Manson, Knauf Fibreglass, Plasti-Fab, Manville
• Louvres	Airolite, Penn, Airstream, West Vent, Nailor, Ruskin, Ventex
• Piping Hangers and Saddles	Grinnell, Myatt
• Plumbing Brass	Crane, American Standard, Cambridge Brass, Waltec, Kohler, Symmons
• Plumbing Fixtures	Crane, American Standard, Kohler
• Pumps - Vertical In-Line and Base Mounted	Armstrong, Aurora, B & G, Taco, Grundfos

• Sinks - Mop	Fiat, Crane, American Standard
• Strainers	Armstrong, Sarco, Mueller, Toyo, Anderson, Metraflex, Yarway
• Tank - Diaphragm Type Expansion	Amtrol, Hamlet and Garneau Inc., B & G
• Thermometers	Trerice, Marsh, Ashcroft, Winters
• Valves - Butterfly	Jenkins, Keystone, DeZurik, Centreline, Dresser, Crane, Bray, Toyo, Grinnell
• Valves - Circuit Balancing	Armstrong, B & G, Tour & Anderson
• Valves – Ball (Flushing water and Heat Exchanger Effluent)	American Valve
• Valves – Control Valves	Belimo, Honeywell, Johnson *(Valve actuators to be supplied by same manufacture of damper actuators)*
• Valves - Drain, Radiator	Jenkins,Dahl, Crane, Toyo
• Valves, Bronze – Check, Ball	Jenkins, Toyo, Crane, Milwaukee
• Valves - Pressure Reducing	Armstrong, Bell & Gossett, Taco
• Valves - Relief	Armstrong, Bell & Gossett, Taco
• Valves - Silent Check	Val-matic, APCO, StreamFlo
• Valves - Suction Diffusers	Armstrong, B&G, Taco
• Valves - Thermostatic Mixing	Symmons, Powers, Leonard
• Vent Caps	Jenn-Air, Penn Ventilator
• Vent Sets	Greenheck, Trane, Sheldons, Buffalo, New York, Brundage, Loren Cook, Lau
• Vibration Isolation	Mason, Vibro Acoustic
• Water Closet Seats	Olsonite, Moldex, Beneke

1.28 Related Work in Other Sections

.1 Refer to other Specification Sections to complete list of equipment Supplied by others.

1.29 Installation

.1 Make all mechanical connections to equipment supplied by others under this Contract. This shall include all water, drain, gas, exhaust, traps, ductwork and similar connections required. Provide isolation valves, unions, flanges and traps as required for a complete installation.

.2 Change to rough-in of services or final equipment connections due to a change in the make of equipment from that specified shall be made at no extra cost to the City, provided that proper Shop Drawings are available for rough-in. Prior to commencing installation of

rough-in for the equipment, co-ordinate with the final reviewed equipment Shop Drawings and with the Manufacturer.

.3 Exposed piping shall be painted as per Architect's instructions.

.4 Arrange piping connections to allow for equipment removal.

.5 Equipment supplied by others and requiring hook-up is as follows:

2. PRODUCTS

2.1 Counter Flashing Materials

.1 Counterflashings: galvanized sheet steel of 0.85 mm (22 ga) minimum thickness.

.2 Counterflashings are attached to mechanical equipment and lap the base flashings on the roof curbs.

.3 All joints in counterflashings shall be flattened and soldered double seam. Storm collars shall be adjustable to draw tight to pipe with bolts. Caulk around the top edge. Storm collars shall be used above all roof jacks.

.4 Vertical flange section of roof jacks shall be screwed to face of curb.

3. EXECUTION

.1 Not Applicable.

END OF SECTION

DOCUMENTATION

1. GENERAL

1.1 Scope

.1 Operating and Maintenance (O&M) Manuals.

.2 Record Drawings.

1.2 Quality Assurance

.1 Work specified in this Section shall be performed by the Contractor.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

.1 Refer to Division 1.

.2 Index according to the following system:

1.0 Mechanical Systems:

Title page.

1.1 List of Mechanical Drawings:

1.2 System Descriptions:

Provide complete description of the operating sequence for all systems. Include detailed system description, with individual components described, explanation of how components interface with others and to the complete system, location of thermostats, controllers or operating variances, and controller operating setpoints.

1.3 Operating Division:

Provide complete and detailed operation of major components and systems. Provide information on location of components, how to energize switches and controls, how components interface with other components, operation of controls including operational sequence, operational changes for summer of winter operation, how to accomplish the changeover, complete trouble shooting sequence, emergency operating sequences in event of major component failure, and safeguards to indicate if equipment goes off-line.

1.4 Maintenance and Lubrication Division:

Provide general maintenance and lubrication schedule for major components to include daily, weekly, monthly, semi-annual and yearly checks and tasks. Explain

how to execute maintenance tasks required for typical equipment such as bearings, drives, motors, and filters. Compile this information for equipment and separate from Shop Drawings.

1.5 List of Equipment Suppliers and Contractors:

Provide list of equipment Suppliers and Contractors, including address and telephone number. Outline procedures for purchasing parts and equipment.

Certification (2.0, 2.1, ...):

Include copy of test data on degreasing and flushing of heating system, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed on piping systems, equipment alignment certificates, copy of balancing data for air and water systems, copy of valve tag identification and pipe colour code, inspection approval certificates for plumbing system, heating and ventilation systems and operational tests on oil-fired equipment.

Shop Drawings and Maintenance Bulletins (3.0, 3.1, ...):

Provide materials received in compliance with clause "Shop Drawings".

2.2 Record Drawings

.1 Refer to Division 1.

.2 The Contractor shall keep on-site, available to the Contract Administrator at all times and particularly for each regularly scheduled Site meeting, a complete set of prints, edge bound, that are to be updated daily showing any and all deviations and changes from the Contract Drawings. This set of Drawings is to be used only for this purpose, and must not be used as the daily general reference set.

.3 Provide record Drawings which identify location of dampers, access doors, tagged valves, and actual room names or numbers. As well, deviations that are to be recorded shall include in general, items that are significant or are hidden from view and items of major importance to future O&M, and to future alterations and additions including cleanouts and isolation valves.

3. EXECUTION

3.1 General

.1 Submit documents to the Contract Administrator for approval prior to transmitting to the City.

3.2 Record Drawings

.1 Enter dimensions from building line to all buried services, including co-ordinates and depth elevations of manholes, tanks, outside shut-off valves, and other similar elements.

.2 Service connections to sewer lines entering a building shall be recorded as to horizontal dimension from a convenient building element with suitable depth elevations relating to main floor level and sea level datum.

.3 Sewer lines which are placed beneath floor slabs shall be located such that each point of entry, change in direction, and irregularity is located by dimension from column grid lines on the as-built Drawings. Depth below slabs shall be given.

.4 At substantial completion, employ a competent CAD draftsperson to transfer all deviations, including those called up by Addenda, revisions, clarifications, Shop Drawings, and Change Orders (CO), on a copy of Bid CAD files. From these files plot a set of as-built sepias. Drafting quality shall be same as original Drawings.

The CAD disks may be borrowed from the Contract Administrator. Each "as-built" sepia shall bear the Contractor's identification, the date of record and the notation "We hereby certify that these Drawings represent the As-Built Record of Construction." The Contractor's signature and company seal shall be placed below that notation.

.5 At substantial completion, employ a competent drafts person to transfer all deviations, including those called up by Addenda, revisions, clarifications, Shop Drawings and CO on a set of reverse sepias. Drafting quality shall be same as original Drawings.

The sepias may be purchased from the Contract Administrator at cost. Each "as-built" Mylar shall bear the Contractor's identification, the date of record and the notation "We hereby certify that these Drawings represent the As-Built Record of Construction." The Contractor's signature and company seal shall be placed below that notation.

END OF SECTION

TESTING

1. GENERAL

1.1 Scope

.1 Test domestic water piping.

.2 Test sanitary sewer piping.

.3 Test storm sewer piping.

.4 Test compressed air piping.

.5 Test low velocity ducts.

.6 Test medium and high velocity ducts.

1.2 Quality Assurance

.1 Test equipment and material where required by Specification or authority having jurisdiction to demonstrate its proper and safe operation.

.2 Test procedures in accordance with the current applicable portions of American Society of Mechanical Engineers (ASME), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and other recognised test codes as far as field conditions permit.

.3 Perform tests on-site to the satisfaction of the Contract Administrator.

.4 Piping, fixtures or equipment shall not be concealed or covered until inspected and approved by the Contract Administrator. Provide ample written notice (two (2) working days) to the Contract Administrator before tests.

.5 Co-ordinate with Contract Administrator at start of project, those tests that will require witnessing by the Contract Administrator.

.6 Prior to starting, testing, balancing, adjusting and cleaning processes, verify with Contract Administrator any tests required to be witnessed. Provide sufficient notice to Contract Administrator prior to commencement of procedures.

.7 The Contract Administrator shall be allowed to witness any testing, adjusting, starting, balancing and cleaning procedures.

.8 Assume all costs associated with testing, including the supply of testing or cleaning medium.

.9 All starting, testing procedures shall be in accordance with applicable portions of the latest, current ASME, ASHRAE, Associated Air Balance Council (AABC), Canadian Standards Association (CSA), National Fire Protection Association (NFPA), Sheet Meal and Air Conditioning Contractors' National Association (SMACNA), American Society for Testing

and Materials (ASTM) and American Society of Plumbing Engineers (ASPE) codes and standards.

.10 Assume all liabilities associated with testing.

1.3 Submittals

.1 Obtain certificates of approval, acceptance, and comply with current rules and regulations from authorities having jurisdiction and include in O&M Manuals.

.2 Perform tests as specified and upon completion of mechanical installation. Provide certification of tests with detailed data as required. Itemize each test as to time performed and personnel responsible. Include in O&M Manuals.

1.4 Liability

.1 Take charge of plant during tests, assume responsibility for damages in event of injury to personnel, building or equipment and bear costs for liability, repairs, and restoration in this connection.

2. PRODUCTS

Not Applicable.

3. EXECUTION

3.1 Pressure Tests

.1 Provide equipment, materials and labour for tests and pay expenses. Use test instruments from approved laboratory or Manufacturer and furnish certificate showing degree of accuracy. Install permanent gauges and thermometers used for tests just prior to tests to avoid possible changes in calibration.

.2 Carry out tests for eight (8) hour period and maintain pressure with no appreciable pressure drop. Where leakage occurs, repair and re-test and pay necessary costs for re-witnessing.

.3 Drainage Systems: Test by filling with water to produce water pressure to 30 kPa (5 psi) minimum and 62 kPa (10 psi) maximum.

.4 Water/Glycol Piping: Test to 1-1/2 times maximum working pressure or 1033 kPa (150 psi), whichever is greater, water pressure measured at system low point.

.5 Ducts: Test ducts as per current edition of SMACNA Manual.

.6 Check systems during application of test pressure including visual check for leakage of water test medium, soap bubble test for air.

.7 During heating and cooling piping system tests, check linear expansion at elbows, U bends, expansion joints and offsets for proper clearance.

.8 When using water as test medium for system not using water, evacuate and dehydrate the piping and certify the lines are dry. Use agency specializing in this type of Work.

.9 Should tests indicate defective Work or variance with specified requirements, make changes immediately to correct the defects. Correct leaks by re-making joints in screwed fittings, cutting out and re-welding welded joints, re-making joints in copper lines. Do not caulk.

END OF SECTION

VIBRATION ISOLATION

1. GENERAL

1.1 Scope

.1 Supply all labour, materials and equipment required and necessary to isolate and restrain the equipment as indicated on the Drawings and specified herein and guarantee the function of the materials and equipment supplied.

.2 Install 300 mm (12 in.) long flex connection on all ductwork connected to isolated equipment.

1.2 Qualifications

.1 All vibration isolators and bases shall be supplied by an acceptable Supplier with the exception of isolators which are factory installed and are standard equipment with the machinery.

.2 Provide shop and placement Drawings for all vibration isolation elements for review, before materials are ordered. The Drawings shall bear the stamp and signature of the responsible Supplier's Technical Representative.

.3 The Work shall be carried out in accordance with the Specification and, where applicable, in accordance with the Manufacturer's instructions and only by workmen experienced in this type of Work.

1.3 Samples

.1 Samples of materials required to complete the Work of this Section shall be submitted to the Contract Administrator for inspection and review, prior to submission of the Shop Drawings.

1.4 Inspection

.1 A qualified representative of the isolator Manufacturer shall inspect the isolated equipment after installation and submit a concise report stating any deficiencies in the installation.

2. PRODUCTS

2.1 Isolators

.1 Spring isolators located out of doors or in humid areas shall have Rustoleum painted housing and neoprene coated springs, unless otherwise indicated on Drawings.

.2 Isolation mounts for equipment with operating weights substantially different from the installed weights, such as chillers or boilers, shall have adjustable limit stops.

2.2 Open Spring Isolators

.1 Springs shall be "ISO-Stiff" having equal stiffness in the horizontal and vertical planes with a working deflection between 0.3 and 0.6 of solid deflection.

.2 Spring mounts shall be complete with levelling devices, minimum 6 mm (1/4 in.) thick neoprene sound pads and zinc chromate plated hardware.

.3 Sound pads shall be sized for a minimum deflection of 1.2 mm (1/16 in.) and shall meet the requirements for neoprene isolators.

2.3 Closed Spring Isolators

.1 Compression springs shall be used both for hangers and floor mount isolators.

.2 Springs shall be stable under operating conditions.

.3 Housings shall incorporate a minimum 6 mm (1/4 in.) thick sound pad sized for a minimum static deflection of 1.2 mm (1/16 in.) meeting the requirements for neoprene isolators.

.4 Floor mount units shall incorporate neoprene side stabilizers with a minimum 6 mm (1/4 in.) clearance.

2.4 Neoprene Isolators

.1 All neoprene isolators shall be tested to latest American Society for Testing and Materials (ASTM) Specifications.

.2 Where a ribbed pad is used, the height of the ribs shall not exceed 0.7 times the width of the rib. A steel layer shall be used to distribute the load in a multi-layered unit.

.3 Neoprene pads or elements shall be selected at the Manufacturer's optimum recommended loading and shall not be loaded beyond the limit specified in the neoprene Manufacturer's literature.

2.5 Spring Hangers

.1 Hangers capable of a 10° misalignment shall be provided unless otherwise specified.

3. EXECUTION

3.1 Application

.1 Provide vibration isolator for mechanical motor driven equipment throughout, unless specifically noted otherwise.

.2 Set steel bases for 25 mm (1 in.) clearance between housekeeping pad and base. Set concrete inertia bases for 50 mm (2 in.) clearance. Adjust equipment level.

.3 Deflections 12 mm (1/2 in.) and over shall use steel spring isolators.

.4 Deflections 5 mm (0.2 in.) and under shall use neoprene isolators.

.5 Horizontal limit springs shall be provided on fans in excess of 1.5 kPa (6 in wg) static pressure except vertical discharge fans and on hanger supported, horizontally mounted axial fans where thrust due to static pressure exceeds 300 N (68 lbs).

.6 All equipment mounted on vibration isolators shall have a minimum clearance of 50 mm (2 in.) to other structures, piping equipment, etc. All isolators shall be adjusted to make equipment level.

.7 Prior to making piping connections to equipment with operating weights substantially different from installed weights, the equipment shall be blocked up with temporary shims to the final heights. When full load is applied, the isolators shall be adjusted to take up the load just enough to allow shim removal.

.8 Adjustable, horizontal stabilisers on close spring isolators shall be adjusted so that the side stabilisers are clear under normal operating conditions.

.9 All piping connections to isolated equipment shall be supported resiliently for the following distances or to the nearest flexible pipe connector.

Pipe Size mm (in.)	Distance, m (ft)
15 - 40 mm (1/2 in. - 1-1/2 in.)	3.0 (10)
50 - 65 mm (2 in. - 2 1/2 in.)	4.5 (15)
75 - 100 mm (3 in. - 4 in.)	7.0 (25)
125 - 200 mm (5 in. - 8 in.)	9.0 (30)
225 - 275 mm (9 in. - 11 in.)	13.5 (45)
300 - 350 mm (12 in. - 14 in.)	15.0 (50)

The three closest hangers to the vibration source shall be selected for the lesser of a 25 mm (1 in.) static deflection or the static deflection of the isolated equipment. The remaining isolators shall be selected for the lesser of the 25 mm (1 in.) static deflection or 1/2 the static deflection of the isolated equipment.

.10 Spring hangers shall be installed without binding.

.11 Adjust isolators as required and ensure springs are not compressed.

.12 Provide neoprene side snubbers or retaining springs where side torque or thrust is developed.

.13 Where movement limiting restraints are provided, they shall be set in a position with minimum 6 mm (1/4 in.) air gap. Restraints, isolator equipment and attachment points shall be designed to withstand the impact of the isolated equipment subjected to an acceleration not exceeding 3 g without permanent distortion or damage.

.14 Wiring connections to isolated equipment shall be flexible.

.15 Steam pressure reducing valve stations and associated piping shall be supported resiliently for the following distances unless otherwise indicated on the Drawings:

Pipe Size mm (in.)	High Pressure Side m (ft.)	Low Pressure Side m (ft.)
15 - 40 mm (1/2 in. - 1 1/2 in.)	3.0 (10)	9.0 (30)
50 - 65 mm (2 in. - 2 1/2 in.)	4.5 (15)	13.5 (45)
75 - 100 mm (3 in. - 4 in.)	7.0 (25)	21.0 (75)
125 - 200 mm (5 in. - 8 in.)	9.0 (30)	27.0 (90)
225 - 275 mm (9 in. - 11 in.)	13.5 (45)	40.5 (135)
300 - 350 mm (12 in. - 14 in.)	15.0 (50)	45.0 (150)

3.2 Performance

.1 Install isolators of type and deflection as indicated on the following table.

The required static deflection of isolators for equipment exceeding 0.35 kW (1/2 Hp) is indicated below. Spring isolators shall be "open spring". Closed spring isolators shall only be used where specified.

Machine Speed r/min	Main Floor		Mezzanine Mechanical Room	
	Under 15 kW (20 Hp)	Over 15 kW (20 Hp)	Normal	Critical
Under 400	Special*	Special*	Special*	Special*
400 - 600	25 mm (1 in.)	50 mm (2 in.)	90 mm (31/2 in.)	Special*
600 - 800	12 mm (1/2 in.)	25 mm (1 in.)	50 mm (2 in.)	90 mm (31/2 in.)
800 - 1100	5 mm (3/16 in.)	12 mm (1/2 in.)	25 mm (1 in.)	50 mm (2 in.)
1100 - 1500	3 mm (1/8 in.)	4 mm (5/32 in.)	5 mm (3/16 in.)	12 mm (1/2 in.)

* "Special" indicates as directed by the acoustical consultant.

END OF SECTION

METERS AND GAUGES

1. GENERAL

1.1 Scope

.1 Provide meters, gauges, and taps where shown on Drawings and/or specified herein.

.2 Submit Shop Drawings of proposed Products to the Contract Administrator for review.

.3 Submit data sheets on thermometers and pressure gauges indicating service, and temperature or pressure ranges to the Contract Administrator for review.

2. PRODUCTS

2.1 Thermometers

.1 Dial Thermometers: 75 mm (3 in.) diameter dial in drawn steel case, bimetallic helix actuated, brass separable socket of flange and bushing, glass cover, adjustable pointer.

.2 Mercury Thermometer: Red reading mercury filled, 2° graduations, aluminum case, 230 mm (9 in.) scale, straight shank, separable socket, adjustable angle.

2.2 Thermometer Well

.1 Stainless steel suitable for stem type thermometer with gasket and cap except in potable water and open systems, in which case brass type shall be used.

2.3 Pressure Gauges

.1 100 mm (4 in.) diameter, drawn steel case, phosphor bronze bourdon tube, brass movement, extruded brass socket, 1% midscale accuracy, front calibration adjustment, black figures on white background. Provide gauge cock and syphon for steam service, pulsating damper and pet cock for water service.

2.4 Pressure Gauge Taps

.1 Brass needle valve.

2.5 Static Pressure Gauges

.1 Dial Gauge: 100 mm (4 in.) dial, diaphragm actuated, suitable for positive, negative or differential pressure measurement. Accuracy within +2% of full scale, complete with static pressure tips and mounting accessories.

.2 Inclined Vertical Manometer: Molded plastic manometer, accuracy within +3% of full scale, suitable for positive, negative or differential pressure measurement, complete with static pressure tips and mounting accuracy.

3. EXECUTION

3.1 Installation

.1 Provide one pressure gauge per pump installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

.2 Select gauges so that normal operating point is approximately mid-point of instrument range.

.3 On pipes 65 mm (1½ in.) and smaller, place well in tee used in lieu of an elbow to accommodate well.

3.2 Meters and Gauges Installation Schedule

.1 Pressure Gauges:

- Pumps
- Expansion tanks
- Pressure tanks
- Leaving side of automatic make-up valves
- and where shown on Drawings

.2 Pressure Gauge Taps:

- Both sides of two-way control valves
- All lines to three-way control valves
- Major coils, inlet and outlet
- Heat exchangers, inlet and outlet, tube and shell side
- Heat pumps, inlet and outlet
- and where shown on Drawings

.3 Thermometers:

- Heat pumps, inlet and outlet
- Boiler, inlet and outlet
- Supply and return headers of central equipment
- Heat exchangers, inlet and outlet tube and shell side
- Heating and cooling coils, inlet and outlet
- and where shown on Drawings

.4 Thermometer Wells Only:

- All lines to three-way control valves

- and where shown on Drawings

.5 Static Pressure Gauges:

- Across built-up filter banks
- Across unitary filter sections
- Across supply and return fans
- and where shown on Drawings

.6 Static Pressure Taps:

- Across all major dampers
- Across heating and cooling coils
- and where shown on Drawings

END OF SECTION

SUPPORTS, ANCHORS AND SEALS

1. GENERAL

1.1 Scope

.1 Pipe hangers and supports.

.2 Duct hangers and supports.

.3 Flashing for mechanical equipment.

.4 Sleeving for mechanical equipment.

.5 Pipe anchors.

1.2 Reference Standards

.1 Pipe supports shall meet the requirements of current edition of American National Standards Institute (ANSI) B31.1, Power Piping.

.2 Duct hangers shall follow the recommendations of the current edition of the Sheet Metal and Air Conditioning National Association (SMACNA) Duct Manuals.

1.3 Submittals

.1 Submit Shop Drawings of each factory manufactured component.

1.4 General Requirements

.1 Provide hangers and supports to secure equipment in place, prevent vibration, maintain grade, provide for expansion and contraction and to accommodate insulation; provide insulation protection saddles.

.2 Install supports of strength and rigidity to suit loading without unduly stressing building. Locate adjacent to equipment to prevent undue stresses in piping and equipment.

.3 Select hangers and supports for the service and in accordance with the Manufacturer's recommended maximum loading. Hangers shall have a safety factor of 5 to 1.

.4 Fasten hangers and supports to building steel or inserts in concrete construction.

.5 Provide and set sleeves required for equipment, including openings required for placing equipment. Provide sleeves for all pipe and duct penetrations through walls, ceilings, floors and footings.

.6 Dielectrically isolate dissimilar metals.

.7 Obtain approval from the Contract Administrator prior to drilling for inserts and supports for piping systems.

.8 Obtain approval from the Contract Administrator prior to using percussion type fastenings.

.9 Use of piping or equipment for hanger supports is not permitted.

.10 Use of perforated band iron, wire or chain as hangers is not permitted.

.11 Do not weld piping, ductwork or equipment supports to building metal decking or building structural steel supports unless prior written approval has been obtained from the Contract Administrator.

.12 Where deemed necessary by the Contractor Administrator the Contractor shall, at his own cost, employ a structural engineer to design equipment supports and/or pipe anchors.

2. PRODUCTS

2.1 Inserts

.1 Inserts shall be malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms.

.2 Size inserts to suit threaded hanger rods.

2.2 Pipe Hangers and Supports

.1 Hangers: Pipe sizes 15 mm (½ in.) to 40 mm (1½ in.): Adjustable wrought steel ring.

.2 Hangers: Pipe sizes 50 mm (2 in.) to 100 mm (4 in.) and Cold Pipe Sizes 150 mm (6 in.) Over: Adjustable wrought steel clevis.

.3 Hangers: Hot Pipe Sizes 150 mm (6 in.) and Over: Adjustable steel yoke and cast iron roll.

.4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 150 mm (6 in.) and over.

.5 Wall Support: Pipe Sizes to 80 mm (3 in.): Cast iron hook.

.6 Wall Support: Pipe Sizes 100 mm (4 in.) and Over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipe sizes 150 mm (6 in.) and over.

.7 Vertical Support: Steel riser clamp.

.8 Floor Support: Pipe Sizes to 100 mm (4 in.) and All Cold Pipe Sizes: Steel adjustable pipe saddle, locknut nipple, floor flange and concrete pier to steel support.

.9 Floor Support: Hot Pipe Sizes 125 mm (5 in.) and over: Adjustable steel roll and stand, steel screws and concrete pier or steel support.

.10 Install hangers so they cannot become disengaged by movements of supported pipe.

.11 Provide copper plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping. Provide galvanized hangers and supports for galvanized piping.

2.3 Hanger Rods

.1 Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.4 Duct Hangers and Supports

.1 Conform to current edition of SMACNA handbooks.

2.5 Flashing

.1 Steel Flashing: 0.55 mm (26 ga) galvanized steel.

.2 Lead Flashing: 25 kg/m² (5 lb/ft²) sheet lead for waterproofing, 5 kg/m² (1 lb/ft²) sheet lead for soundproofing.

.3 Safes: 25 kg/m² (5 lb/ft²) sheet lead or 0.5 mm (0.02 in) neoprene.

.4 Caps: Steel, 0.7 mm (24 ga) thickness minimum, 1.6 mm (16 ga) thickness at fire resistance structures.

2.6 Sleeves

.1 Pipe sleeves shall be provided for piping passing through walls and floors. Minimum 0.61 mm (24 ga) galvanized sheet metal. Sleeves shall extend 25 mm (1 in.) on either side of the wall.

.2 Schedule 40 steel pipe shall be used as floor pipe sleeves in wet areas with a 50 mm (2 in.) up-stand.

.3 Ducts: Form sleeves with galvanized steel.

.4 Size large enough to allow for expansion with continuous insulation.

.5 Pipe sleeves are not required where pipes pass through cored concrete walls or floors.

2.7 Pipe Seals

.1 Provide “Link-Seal” pipe sealing system where passing through room foundation walls.

2.8 Finishes on Hanger Rods, Hangers and Supports

.1 All steel hanger rods, hangers and supports shall be galvanised or factory primed with alkyd red oxide primer to Canadian Government Specification Board (CGSB) 1-GP-40m.

3. EXECUTION

3.1 Inserts

.1 Use inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practicable.

.2 Set inserts in position in advance of concrete Work. Provide reinforcement rod in concrete for inserts carrying piping over 100 mm (4 in.) or ducts over 1500 mm (60 in.) wide.

.3 Where concrete slabs form finished ceiling, finish inserts flush with slab surface.

.4 Where inserts are omitted, provide concrete clevis plate anchored to the slab.

3.2 Pipe Hangers and Supports

.1 Support horizontal steel and copper piping as follows:

Nominal Pipe Size	Distance Between Supports		Hanger Rod Diameter
	Steel	Copper	
15 mm (½ in.)	1.8 m (6 ft)	1.5 m (5 ft)	10 mm (0.4 in.)
20 mm to 40 mm (¾ in. to 1½ in.)	2.1 m (7 ft)	1.8 m (6 ft)	10 mm (0.4 in.)
50 mm & 65 mm (2 in. to 2½ in.)	3.0 m (10 ft)	2.4 m (8 ft)	10 mm (0.4 in.)
80 mm & 100 mm (3 in. to 4 in.)	3.6 m (12 ft)	3.0 m (10 ft)	16 mm (0.6 in.)
150 mm to 300 mm (6 in. to 12 in.)	4.2 m (14 ft)	4.0 m (13 ft)	22 mm (¾ in.)
350 mm to 450 mm (14 in. to 18 in.)	6.0 m (20 ft)	--	25 mm (1 in.)

.2 Install hangers to provide minimum 12 mm (½ in.) clear space between finished covering and adjacent Work.

.3 Place a hanger within 300 mm (12 in.) of each horizontal elbow.

.4 Use hangers which are vertically adjustable 40 mm (1½ in.) minimum after piping is erected.

.5 Support horizontal soil pipe near each hub with 1.5 m (5 ft) maximum spacing between hangers.

.6 Support vertical piping at every other floor. Support vertical soil pipe at each floor at hub.

.7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

.8 Where practical, support riser piping independently of connected horizontal piping.

.9 Use oversized hangers to accommodate pipe insulation thickness. For pipes up to 50 mm (2 in.) use high density rigid pipe insulation at hanger location, with an insulation protection shield. For pipes 65 mm (2½ in.) and over, use insulation protection saddle.

3.3 Low Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 750 mm (30 in.) wide: 25 x 1.6 mm (1 in x 16 ga) at 3 m (10 ft) spacing.

.2 790 to 1200 mm (31 to 48 in.) wide: 40 x 1.6 mm (1½ in. x 16 ga) at 3 m (10 ft) spacing.

.3 Over 1,200 mm (48 in.) wide: 40 x 1.6 mm (1½ in x 16 ga) at 2.4 m (8 ft) spacing.

.2 Horizontal Duct on Wall Supports Minimum Sizes:

.1 Up to 450 mm (18 in.) wide: 40 x 1.6 mm (1½ in. x 16 ga) or 25 x 25 x 3 mm (1 x 1 in. x 11 ga) at 2.4 m (8 ft) spacing.

.2 480 to 1,000 m (19 to 40 in.) wide: 40 x 40 x 3 mm (1½ x 1½ x 11 ga) at 1.2 m (4 ft) spacing.

.3 Vertical Duct on Wall Supports Minimum Sizes at 3.65 m (12 ft) spacing:

.1 Up to 610 mm (24 in.) wide: 40 x 1.6 mm. (1½ in. x 16 ga).

.2 640 to 900 mm (25 to 36 in.) wide: 25 x 25 x 3 mm (1 x 1 in. x 11 ga).

.3 940 to 1,200 mm (37 to 48 in.) wide: 30 x 30 x 3 mm. (1.2 x 1.2 in. x 11 ga).

.4 Over 1,200 mm (48 in.) wide: 50 x 50 x 3 mm (2 x 2 in. x 11 ga).

.4 Vertical Duct Floor Supports Minimum Sizes, riveted or screwed to ducts:

.1 Up to 1,520 mm (60 in.) wide: 40 x 40 x 3 mm (1½ x 1½ in. x 11 ga).

.2 Over 1,520 mm (60 in.) wide: 50 x 50 x 3 mm (2 x 2 in. x 11 ga).

3.4 Medium and High Velocity Duct Hangers and Supports

.1 Hanger Minimum Sizes:

.1 Up to 900 mm (36 in.) wide: 2 at 25 x 1.6 mm (1 in. x 16 ga) at 3 m (10 ft) spacing.

.2 940 to 1,520 mm (37 to 60 in.) wide: 2 at 25 x 1.6 mm (1 in. x 16 ga) at 2.4 m (8 ft) spacing and 50 x 50 x 6 mm (2 x 2 in. x 0.25 in.) trapeze.

.3 1,550 to 3,050 mm (61 to 120 in.) wide: 2 at 38 x 2.6 mm (1½ in. x 12 ga) at 2.4 m (8 ft) spacing and 50 x 50 x 7 mm (2 x 2 in. x 0.3 in.) trapeze.

.4 2,070 to 6,700 mm (121 to 264 in.) wide: 3 at 10 mm (½ in.) diameter at 1.2 m (4 ft) spacing and 65 x 65 x 5 mm (2½ x 2½ x 0.2 in.) trapeze.

.2 Round Duct Hangers Minimum Sizes at 3 m (10 ft) spacings:

.1 Up to 460 mm (18 in.) diameter: 25 x 1.6 mm (1 in. x 16 ga).

.2 480 to 900 mm (19 to 36 in.) diameter: 25 x 2.6 mm (1 in x 12 ga).

.3 940 to 1,270 mm (37 to 50 in.) diameter: 40 x 2.6 mm (1½ in x 12 ga).

.4 1,300 to 2,130 mm (51 to 84 in.) diameter: 2 at 40 x 2.6 mm (1½ x 12 ga) from girth reinforcing angle.

.3 Vertical Duct Floor Supports Minimum Sizes:

.1 Up to 1,220 mm (48 in.) wide: 40 x 40 x 3 mm (1½ x 1½ in. x 11 ga).

.2 Over 1,220 mm (48 in.) wide: 50 x 50 x 3 mm (2 x 2 in. x 11 ga).

.3 Rivet to duct and tie angles together with rod, angles or band Iron.

.4 Angle reinforcing may be used for support omitting trapeze.

3.5 Equipment Bases and Supports

.1 Provide for floor mounted equipment, reinforced concrete housekeeping bases poured directly on structural floor slab 100 mm (4 in.) thick minimum, extended 100 mm (4 in.) minimum beyond machinery bedplates. Provide templates, anchor bolts and accessories required for mounting and anchoring equipment.

.2 Construct supports of structural steel members or steel pipe and fittings. Brace and fasten with flanges bolted to structure.

.3 Rigidly anchor ducts and pipes immediately after vibration connections to equipment.

3.6 Flashing

.1 Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.

.2 Flash vent and soil pipes projecting 75 mm (3 in.) minimum above roof membrane with lead worked 25 mm (1 in.) minimum into hub, 200 mm (8 in.) minimum clear on sides with

minimum 600 x 600 mm (24 x 24 in.) sheet size. For pipes through outside walls turn flange back into wall and caulk.

.3 Flash floor drains over finished areas with lead 250 mm (10 in.) clear on sides with minimum 920 x 920 mm (36 x 36 in.) sheet size. Fasten flashing to drain clamp device.

.4 Provide curbs for mechanical roof installations minimum 200 mm (8 in.) high. Flash and counterflash with steel; solder and make waterproof.

.5 Provide continuous lead or neoprene safes below air supply casings, built-up mop sinks, shower stalls, shower room floors located above finished rooms. Solder at joints, flash into floor drains and turn up 150 mm (6 in.) into walls or to top of curbs and caulk into joints.

.6 Provide lead flashing around ducts and pipes passing from equipment rooms, installed according to Manufacturer's data for sound control.

3.7 Sleeves

.1 Set sleeves in position in advance of concrete Work. Provide suitable reinforcing around sleeve.

.2 Extend sleeves through potentially wet floors 25 mm (1 in.) above finished floor level. Caulk sleeves full depth and provide floor plate.

.3 Piping and ductwork passing through floor, ceiling or wall, close off space between duct and sleeve and non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

.4 Piping passing through mechanical room floor, roof or wall, close off space between pipe and sleeve with synthetic rubber compound mechanical type seals.

.5 Sleeves provided through walls or floors where liquids could potentially pass from one side to the other, provide sleeves with a 25 mm (1 in.) "flange" welded to the external face of the sleeve at the mid point of the thickness of the structure to provide a water stop.

.6 Install chrome plated escutcheons where piping passes through finished surfaces.

END OF SECTION

PIPE AND PIPE FITTINGS

1. GENERAL

1.1 Quality Assurance

.1 Welding materials, fabrication standards and labour qualifications must conform to American national Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) B31.1, ANSI B16.25, ASME Section IX, and the Provincial Board of Labour Regulations latest current editions.

.2 Use welders fully qualified and licensed by Provincial Authorities.

.3 Domestic Water, Drainage and Vent Piping: current Provincial and Municipal Codes.

.4 All below grade steel piping shall be yellow jacketed with taped and sealed joints.

.5 Non specified pipe joining and pipe fitting methods such as T-drill and press fit are not permitted in any piping system covered under Division 15.

2. PRODUCTS

2.1 Pipe

	Service	Material
.1	Sanitary drainage, and vent, inside building, above ground	`DWV' copper, ASTM B306 Cast iron, CSA B70
.2	Sanitary drainage, and vent, inside building, below ground	PVC-DWV, CAN3B182
.3	Storm drainage, inside building, above ground	Cast iron, CSA B70 DWV Copper, ASTM B306
.4	Storm drainage, inside building, below ground	PVC-DWV, CAN3B182.1
.5	Domestic water, above ground (inside building)	Type `K' hard copper for sizes up to 100 mm (4 in.), ASTM B88M Ductile Iron centrifugally cast for cold water main sizes 100 mm (4 in.) and larger, ANSI/AWWA C151/A21.51. No steel piping allowed for domestic hot water.
.6	Domestic Water (buried inside building)	Type `K' soft copper, ASTM B88M
.7	Flushing and Heat Exchanger Effluent	Sch. 40, 304 SS, ASTM A312, Seamless or

	Service	Material
	Water	ERW.
.8	Glycol Piping	Steel, Sch.40, ASTM A53, Grade B
.9	Compressed air, above ground	Steel, Sch. 40, ASTM A53, Grade B, seamless, plain ends, galvanized
.10	Compressed air, below ground	Type ‘K’ soft copper, ASTM B88M
.11	Equipment drains and overflows	Sch.40, galvanized steel, ASTM A120
		Type `L' hard copper ASTM B88M

2.2 Fittings and Joints

	Service	Material	Joint
.1	Sanitary drainage and vent inside building, above ground	Cast iron	Gasket clamp
		Wrought or Cast copper	50-50 Solder
.2	Sanitary drainage and vent, inside building, below ground	PVC-DWV	Solvent weld
.3	Storm drainage, inside building, above ground	Cast iron	Gasket & clamp
		Wrought or cast copper	50-50 solder
.4	Storm drainage, inside building, below ground	PVC-DWV	Solvent weld
.5	Domestic water, above ground	Wrought copper, bronze	Lead free solder, brazed for pipes over 50 mm
		Cast bronze	Screwed
		Ductile Iron pipe	Grooved mechanical
.6	Domestic water, buried	PVC	Hub & spigot, with "O" ring
		Copper pipe	No joints permitted underground
.7	Flushing and Heat	Stainless steel mechanical	Grooved Victaulic, Shurjoint or

	Service	Material	Joint
	Exchanger Effluent Water		Gruv-Lok only
.8	Glycol Piping	Banded malleable iron, 1033 kPa (150 psi), up to 40 mm (1-1/2 in)	Screwed
		Steel, same schedule as pipe, for sizes 50 mm (2 in) and larger	Welded
.9	Compressed air, above ground	3000 # carbon steel, galvanized, sizes up to 40 mm (1-1/2 in)	Screwed
.10	Compressed air, below ground	Copper tube	No joints permitted underground
.11	Equipment drains and overflows	Galvanized banded malleable iron	Screwed
		Wrought copper, bronze	50-50 solder
		Cast brass	Screwed

.12 Use factory fabricated butt welded fittings for welded steel pipes.

.13 Use long radius elbows for steel and cast iron water piping, including grooved mechanical fittings.

2.3 Unions, Flanges and Couplings

.1 Size 50 mm (2 in.) and under: 1033 kPa (150 psi) malleable iron, bronze to iron ground joint unions for threaded ferrous piping, air tested for gas service, all bronze for copper piping.

.2 Sizes 65 mm (2½ in.) and over: 1033 kPa (150 psi) forged steel welding neck flanges for ferrous piping, 1033 kPa (150 psi) bronze slip-on flanges for copper piping. Gaskets shall be 1.5 mm (1/16 in.) thick performed synthetic rubber bonded asbestos. Gaskets for gas service shall be synthetic rubber.

.3 Flange bolting: For systems up to 120°C (250°F), use carbon steel stud bolts, semi-flushed and heavy hex nuts, ASTM A307-GrB. For systems up to 215°C (420°F), use alloy steel bolts ASTM A193-GrB7, and semi-finished heavy hex nuts ASTM A194-Gr2H.

.4 Where permitted by the Contract Administrator, use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some angular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket ethylene propylene diene monomer (EPDM) Grade `E' and steel

bolts. Use galvanized couplings for galvanized pipe. Victaulic brand or Grinnel Gruv-Lok only

3. EXECUTION

3.1 Preparation

.1 Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

.2 Protect all pipes when stored on-site from external conditions and ensure protective coating remains intact.

3.2 Connection

.1 Screw joint steel piping up to and including 40 mm (1½ in.). Weld piping 50 mm (2 in) and larger, including branch connections.

.2 Make screwed joints with full cut standard taper pipe threads with approved non-toxic joint compound applied to male threads only.

.3 Make joints for plain end pipe with gasket and clamp type mechanical fastener.

.4 Clamp cast iron water pipe at fittings with 20 mm (¾ in.) rods and properly anchor and support.

.5 Use grooved mechanical couplings and mechanical fasteners, only where permitted by the Contract Administrator.

.6 Use galvanized couplings with galvanized pipe.

.7 Make connections to equipment, specialty components, and branch mains with unions or flanges.

.8 Provide dielectric type connections wherever joining dissimilar metals in open systems. Brass adapters and valves are acceptable.

.9 Use insulating plastic spacers for copper pipe installation in metal studs.

3.3 Route and Grades

.1 Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping wherever practical at common elevations. Install concealed pipes close to the building structure to keep furring to a minimum.

.2 Slope water piping 0.2% and provide hose bibb drains at low points.

.3 Equip low points with 20 mm (¾ in.) drain valves and hose nipples.

.4 Provide air collection chambers with manual air vent at all high points of system. Collection chambers to be 25 mm (1 in.) dia. or line size whichever is greater and 150 mm (6 in.) high minimum. Square tees may only be used to assist with complete venting and draining.

.5 Make reductions in water and steam pipes with eccentric reducing fittings installed to provide drainage and venting. Top flat for water, bottom flat for steam.

.6 Grade horizontal drainage and vent piping 2% minimum, unless noted otherwise.

.7 Pipe the discharge from all relief valves, safety valves, vents, drains, equipment blowdowns, water columns and overflows to the nearest building drain. Pipe to glycol recovery tanks for a glycol based system.

3.4 Installation

.1 Install piping to allow for expansion and contraction without unduly stressing pipe or equipment connected.

.2 Provide clearance for proper installation of insulation and for access to valves, air vents, drains and unions.

.3 Install piping material specified as inside the building to 1,500 mm (5 ft) outside of building.

.4 Yellow jacket buried steel lines, joints and fittings, prime coat and paint lines exposed to outdoors.

3.5 Welded Pipe Branch Connections

.1 Make branch connections according to the following schedule.

Legend:

T: Forges tee or reducing tee

S: Socolet

W: Weldolet

Branch Connections (90 degree only)

Branch Diameter, mm (in)

Header Diameter, mm (in)	200 (8)	150 (6)	100 (4)	75 (3)	65 (2½)	50 (2)	40 (1½)	30 (1 ¼)	25 (1)	20 (¾)	15 (½)
200 (8 in.)	S	S	S	S	S	W	W	W	T	T	T
150 (6 in.)	S	S	S	S	S	W	T	T	T	T	
100 (4 in.)	S	S	S	S	S	T	T	T	T		
75 (3 in.)	S	S	S	S	S	T	T	T			
65 (2½ in.)	S	S	S	S	T	T	T				
50 (2 in.)	S	S	S	T	T	T					
40 (1½ in.)	T	T	T	T	T						
30 (1¼ in.)	T	T	T	T							
25 (1 in.)	T	T	T								
20 (¾ in.)	T	T									
15 (½ in.)	T										

Connection Symbols

T: Forges tee or reducing tee

S: Socolet

W: Weldolet

END OF SECTION

VALVES AND STRAINERS

1. GENERAL

1.1 Scope

.1 Ball valves.

.2 Check valves.

.3 Butterfly valves.

.4 Drain valves.

.5 Hose bibbs.

.6 Strainers.

1.2 Manufacturer

.1 Provide valves of the same type by the same Manufacturer throughout.

.2 Provide valves with Manufacturer's name and pressure rating clearly marked on outside of body.

1.3 Shop Drawings

.1 Submit copies of valves "ordering schedule" for review before ordering valves.

.2 Submit detailed Shop Drawings clearly indicating make, model, size, pressure rating, materials of construction and intended service.

2. PRODUCTS

2.1 Domestic Water System

.1 Ball Valves up to 50 mm (2 in.): Brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa (600 psi) non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Butterfly Valves: Cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable ethylene propylene diene monomer (EPDM) seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm (4 in.), heavy duty gear handwheel operator with position indicator for valve sizes 150 mm (6 in.) and over. Minimum rating 1200 kPa (175 psi), 121°C (250°F). Keystone AR2.

.3 Swing Check Valves:

Up to 50 mm (2 in.): Bronze body, screw-in cap, replaceable disc, 860 kPa (125 psi) steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

65 mm (2½ in.) and over: Cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam. Red-White Fig. 435.

.4 Silent Check Valves for Pump Discharge:

Up to 50 mm (2 in.): Bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa (200 psi) water. Val Matic VM-S1400.

65 mm (2½ in.) and over: Wafer style, cast iron body, 316 SS seat, plug, spring and bushing. American National Standards Institute (ANSI) Class 125. Val Matic, Series 1400.

2.2 Flushing Water and Heat Exchanger Effluent Systems

.1 Foot Valves up to 50 mm (2 in): Cast iron body, stainless steel spring, delrin and stainless steel poppet, nitrile seat and polypropylene strainer. Silent operating and normally closed. Threaded connection. Crispin FV Series.

.2 Foot Valves 65 mm (2½ in.) and over: Cast iron body, bronze disc, bushing and seating ring with Buna-N seal, stainless steel screen. Silent operating and normally closed. ANSI Class 125 flange connection. Crispin FV Series.

.3 Ball Valves up to 100 mm (4 in.):

.1 Floating ball design capable of providing bi-directional, tight shutoff in accordance with MSS SP-72.

.2 Rating: 200 WOG.

.3 Body: Cast iron per ASTM A126 class B, with ANSI class 125 flat-face flanges, interior and exterior epoxy coated.

.4 Ball: PFTE infused cast iron with 304 stainless steel blow-out proof stem.

.5 Seats and seals: PTFE

.6 Stem seal: PTFE, externally adjustable chevron type.

.7 Body bolts and nuts: Carbon steel.

.8 Operator: Lever handle.

.9 Standard of acceptance: American Valve model 4000, or as approved by the Engineer.

2.3 Hydronic Systems

.1 Ball Valves up to 50 mm (2 in.): Brass body, chrome plated brass ball, threaded or solder ends, TFE seat and packing. 4134 kPa (600 psi) non-shock WOG rating. Threaded, Red-White Fig. 5044A. Solder joint, Red-White Fig. 5049A.

.2 Butterfly Valves: Cast iron wafer full-lug body, 300 Series stainless steel shaft, bronze disc, replaceable EPDM seat, lever lock handle operator with multiple position lock plate for valve sizes to 100 mm (4 in.), heavy duty gear handwheel operator with position indicator for valve sizes 150 mm (6 in.) and over. Minimum rating 1200 kPa (175 psi), 121°C (250°F). Keystone AR2.

.3 Swing Check Valves:

Up to 50 mm (2 in.): Bronze body, screw-in cap, replaceable disc, 860 kPa (125 psi) steam rating. Threaded, Red-White Fig. 236. Solder ends, Red-White Fig. 237.

65 mm (2½ in.) and over: Cast iron body, regrind-renew swing check, bolted cover, flanged ends, bronze disc and seat ring, rating 860 kPa (125 psi) steam. Red-White Fig. 435.

.4 Silent Check Valves for Pump Discharge:

Up to 50 mm (2 in.): Bronze body, SS stem, 316 SS spring, Teflon disc and seat ring, 430 SS seat screw, threaded ends. 1380 kPa (200 psi) water. Val Matic VM-S1400.

65 mm (2½ in.) and over: Wafer style, cast iron body, 316 SS seat, plug, spring and bushing. ANSI Class 125. Val Matic, Series 1400.

.5 Drain Valves up to 50 mm (2 in.): Brass 2 piece body ball valve, blowout proof stem, Teflon seats, forged brass chrome palted ball, hose end connection with cap and chain by male IP, 4200 kPa (600 psi) WOG rating, Red-White Fig. 5046.

.6 Circuit Balancing Valves: Suitable for throttling. All metal parts non-ferrous, die cast non-porous copper alloy. Flow measuring accuracy ±2%. Positive shut-off, drain connection with cap. Memory balancing feature. Fittings for connection of portable differential pressure meter. Bell & Gosset circuit setter.

.7 Control Valves

.1 Two-way valves: Two-way valves shall have equal percentage characteristics. Size two-way valve operators to close against maximum pump shut-off head.

.2 Size control valves as per following criteria:

- Select control valves in equipment room to supply varying water temperature to the system at 24 kPa (3.5 psi) or less pressure drop.
- Select two-way control valves for coils, heat exchangers, terminal units, etc., with a minimum pressure drop of 35 kPa (5 psi) and a maximum pressure drop of 70 kPa (10 psi).

.3 Valves shall "fail-safe", spring return to normal position.

.4 Provide valves complete with electronic operators. Standard of acceptance: Belimo.

.5 Two Way Valves 15 mm to 50 mm (1/2 in to 2 in):

.1 Ball valve with flow-characterizing disc installed in the inlet of the valve.

.2 Trim: A stainless steel ball and stem.

.3 Body: Nickel-plated, forged brass with female NPT threads. Bodies to 30 mm (1-1/4 in) shall be rated at 4.1 MPa (600 psi) and sizes 40 mm to 50 mm (1-1/2 in to 2 in) at 2.8 MPa (400 psi). Valves shall have a self-aligning, blowout proof stem with a dual EPDM O-ring packing design.

.4 Seats: Fibreglass reinforced PTFE.

.5 Coupling: non-metallic, constructed of high temperature, continual use material shall provide a direct, mechanical connection between the valve body and actuator. The coupling shall be designed to provide thermal isolation and eliminate lateral and rotational stem forces. Vent hole shall be provided to reduce condensation build-up.

.6 Valves shall have a four bolt mounting flange to provide a four position, field changeable, electronic actuator mounting arrangement.

.6 Actuators:

.1 Valve mounting: Direct couple and mount to a stem, shaft or ISO style-mounting pad.

.2 Actuators shall be fully modulating/proportional or on/off as required by Specification Section 15940 and Division 17. Actuators shall have visual position indicators and shall operate in sequence with other devices as required.

.3 Operating temperature range: -30°C to 50°C (-22°F to 122°F).

.4 Proportional actuators shall accept a 0-10 VDC or 0-20 mA input signal and provide a 4-20 mA operating range.

.5 Operating Voltage: 24 VDC with a power consumption not exceeding 8 watts per actuator.

.6 Housing: National Electrical Manufacturers Association (NEMA) 2 rated with a 1 m pre-wired electrical cable.

.7 Spring Return Mechanism: capable of CW or CCW mounting orientation. Spring return actuators with more than 6.8 N-m (60 in-lb) of torque shall have a metal,

manual override crank. Upon loss of signal, a proportional actuator shall fail open or closed based on the minimum control signal.

.8 Actuators shall be capable of being mechanically or electrically paralleled to increase torque if required. Valves requiring greater torque or higher close off may be assembled with multiple low torque actuators.

.9 Running time: 70 seconds.

.10 Fail-position: open for heating, closed for cooling.

.8 Backpressure Valve:

.1 General: Direct operated backpressure regulating valve.

.2 Body: Steel body, NPT screwed connections.

.3 Seat: Buna-N

.4 Seat: Stainless steel

.5 Diaphragm: Neoprene or Buna-N.

.6 Standard of acceptance: Fisher series 98L, Cash FR Series.

2.4 Compressed Air System

.1 Ball Valves up to 40 mm (1-1/2 in.): Carbon steel ASTM A-105 three (3) piece bolted body, 316 SS ball and stem, screwed ends, TFE seat and packing, lever operator. 1,000 WOG rating. Standard of acceptance: Milwaukee 30 Series, 30CS OF.

.2 Check Valves up to 40 mm (1-1/2 in): Forged steel ASTM A-105 piston check valve, bolted bonnet, screwed ends, class 800. Standard of acceptance: Vogt Series 710.

2.5 Valve Operators

.1 Provide valves larger than 100 mm (4 in.) located more than 2.1 m (7 ft) from floor in equipment rooms with chain operated sheaves. Extend chains to 1.5 m (5 ft) above floor and hook to clips to arrange to clear walking aisles.

2.6 Strainers

.1 Size 50 mm (2 in.) and under: Screwed brass or iron body, Y pattern with 0.75 mm (24 ga) stainless steel perforated screen.

.2 Size 65 mm to 100 mm (2½ in. to 4 in.): Flanged iron body, Y pattern with 1 mm (20 ga) stainless steel perforated screen.

.3 Size 125 mm (5 in.) and larger: Flanged iron body, Y pattern with 3 mm (11 ga) stainless steel perforated screen.

.4 Screen free area shall be minimum three (3) times area of inlet pipe.

2.7 Suction Diffuser

.1 For base mounted or floor mounted vertical inline pumps.

Cast iron construction; NPT connections up to 50 mm (2 in.): flanged connections.

Over 65 mm (2½ in.): cast iron straightening fitting, stainless steel combination diffuser - strainer - orifice cylinder with 4.8 mm (3/16 in.) perforations, and permanent magnet. Provide complete with a 16 mesh bronze strainer.

3. EXECUTION

3.1 Installation and Application

.1 Install valves with stem upright or horizontal, not inverted.

.2 Provide threaded lug type butterfly valves for equipment isolation service. Provide wafer or threaded lug type valves for zone shut-off service.

.3 Provide drain valves at main shut-off valves, low points of piping and apparatus and terminal units.

.4 Size drain lines and drain valves equal to size of apparatus drain connection.

.5 For pipe sizes 20 mm (3/4 in.) and over, minimum drain size to be 20 mm (3/4 in.).

.6 Provide hose thread connection with cap and chain for 20 mm (3/4 in.) drain valves located in ceiling and public areas.

.7 Provide male NPT nipples with threaded pipe cap for drain sizes over 20 mm (3/4 in.) where not piped directly to floor drains.

.8 Provide valved drain and hose connections off the bottom of all strainers.

.9 Install circuit balancing valves on the discharge of pumps where indicated.

END OF SECTION

GLYCOL SPECIALTIES

1. GENERAL

1.1 Scope

.1 Glycol mixing/charging tank, fill pump.

.2 Propylene glycol solution.

.3 Manual and automatic air vents.

.4 Air separators.

.5 Relief valves and fittings.

.6 By-pass filter.

.7 Quantity meters.

1.2 Quality Assurance

.1 Thoroughly check system and make necessary corrections if system continually loses solution.

.2 Perform tests determining strength of glycol solution before system is turned over to the City. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

1.3 Submittals

.1 Provide Shop Drawings for all equipment in this Section.

2. PRODUCTS

2.1 Glycol Feed Package

.1 Glycol feed package shall include 180L (48 US gallon) storage/mixing tank with cover; pump suction hose with inlet strainer; pressure pump with thermal cut-out; integral pressure switch; integral check valve; cord and plug; pre-charged accumulator tank with ethylene propylene diene monomer (EPDM) diaphragm, manual diverter valve for purging air and agitating contents of storage tank; pressure regulating valve adjustable 35 to 380 kPa (5 to 55 psi) complete with pressure gauge; integral replaceable strainer; built-in check valve; union connection; 15mm (1/2 in) x 900mm (36 in) long flexible hose with check valve; low level pump cut-out; low level alarm panel with remote monitoring dry contacts. Power supply 115/1∅/60 0.7

amps. Pump performance 0.09 L/s (1.4 usgpm) at free flow, 0.06 L/s (1.0 usgpm) at 345 kPA (50 psi), self-priming to 2.1 m (7 feet).

.2 Pressure pump shall be capable of running dry without damage.

.3 Unit shall be completely pre-assembled and certified by a recognized testing agency to Canadian Standards Association (CSA) standard C22.2 No.68.

.4 Pump and tank capacity: See Schedule.

.5 Standard of acceptance: 'Axiom Industries Ltd.' model SF100.

2.2 High Capacity Automatic Air Vents

.1 A float actuated high capacity air vent designed to purge free air from the system and provide shutoff at pressures up to 1035 kPag (150 psig) at a maximum temperature of 120°C (250°F). The design of the high capacity air vent shall prevent air from entering the system if system pressure should drop below atmospheric pressure. The high capacity air vent shall purge free at pressures up to 1035 kPag (150 psig) during normal operation. The high capacity air shall be constructed of cast iron and fitted with components of stainless steel, brass and EPDM.

.2 Standard of Acceptance: Bell & Gossett model 107A.

2.3 Automatic Air Vents

.1 Provide automatic air vents where shown on Drawings. Vents shall be non-ferrous construction, rated for 1000 kPag (145 psig) and 116°C (240°F) operating temperature.

.2 Standard of Acceptance: Bell & Gossett model 7 or 87.

2.4 Manual Air Vents

.1 Provide manual air vents with 25 mm (1 in) or line diameter pipe which ever is greater to form air collection chamber. Collection chamber to be 150 mm (6 in) high.

2.5 Air Separators

.1 Provide, as shown on plans, centrifugal type air separator. The unit shall have flanged inlet and outlet connections tangential to the vessel shell. The unit shall have an internal stainless steel air collector tube with 4 mm (5/32 in) diameter perforations and 63% open area designed to direct accumulated air to the high capacity air vent on an air elimination system via an NPT vent connection at the top of unit.

.2 A blowdown connection shall be provided to facilitate routine cleaning of the separator.

.3 Manufacture to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

.4 Vessel shell diameter is to be three times the nominal inlet/outlet pipe diameter, with a minimum vessel volume for sufficient velocity reduction. The air separator must be designed, constructed and stamped for 861 kPag (125 psig) at 177°C (350°F) in accordance with Section VIII, Division I of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, and registered with the National Board of Boiler and Pressure Vessel Inseptors.

.5 The air separator(s) shall be painted with one shop coat of light gray air dry enamel.

.6 A Manufacturer's Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code, shall be furnished for each air separator upon request.

.7 Refer to Schedule for size and performance.

.8 Standard of Acceptance: Bell & Gossett.

2.6 Relief Valves

.1 Provide ASME rated direct spring loaded type, lever operated non-adjustable factory set discharge pressure as indicated.

2.7 Bypass Filter

.1 Unit to consist of cartridge filter, flow indicator, flow control valves and filter cartridges. Cartridge filter; stainless steel shell of single centre bolt construction with cast nick-plated brass head, drain plug and air vent. Flow indicator - cast bronze body with two (2) sight glasses of high temper, thermo shock-resistant glass and nylon rotor on stainless steel pin.

Flow Control Valves: Cast Bronze Globe Valves, 25 mm (1 in.) Female NPT Thread.

Filter cartridges: 10 each of 10 micron retention, and 20 micron retention.

Manufacturer: Guthrie Hydroniclean System.

2.8 Chemical Pot Feeder

.1 150 mm (6 in.) diameter x 550 mm (22 in.) long feeder, suitable for 861 kPa (125 psi) operating pressure complete with isolation valves on 20 mm (3/4 in.) inlet and outlet lines. 20 mm (3/4 in.) drain valve 40 mm (1 1/2 in.) fill complete with filling funnel.

2.9 Expansion Tank

.1 Pre-charged horizontal steel expansion tank with integral heavy duty Butyl rubber diaphragm. The tank shall have 13 mm (1/2 in NPT) system connections and a 0.302"-32 charging valve connection to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 861 kPa (125 psi) working pressure.

.2 Refer to Section 15999 – Schedules for selections and sizes.

.3 Standard of acceptance: Bell & Gossett Series D.

3. EXECUTION

3.1 Air Vents

.1 Provide manual type at system high points and convection type heating units.

.2 Where large air quantities can accumulate, provide enlarged air collection standpipe.

3.2 Air Separator

.1 Provide on suction side of system circulation pump and connect to expansion tank.

3.3 Relief Valve

.1 Provide relief valves on pressure tanks, low pressure side of reducing valves, heating convertors, expansion tanks and where indicated.

.2 Drain relief valve to glycol collection tanks. Do not waste glycol to floor drains.

.3 System relief valve capacity shall equal make-up pressure reducing valve capacity. Equipment relief valve capacity shall exceed input rating of connected equipment.

.4 Where one (1) line vents several relief valves, cross sectional areas shall exceed sum of individual vent areas.

3.4 Bypass Filter

.1 Install between pump's suction and discharge. Provide isolation valves and sight glass as indicated.

3.5 Chemical Pot Feeder

.1 Install one (1) chemical pot feeder for each glycol system.

END OF SECTION

INHIBITED GLYCOL FLUID

1. GENERAL

1.1 Scope

.1 The Work under this Section shall include labour, materials, equipment, appliances, instruments, services and transportation in connection with the aqueous based heat transfer fluid. Work shall be as indicated in the Specification and as noted on the Drawings.

.2 Clean, degrease and thoroughly flush the systems.

.3 Mix and charge the inhibited glycol solution.

.4 Test and certify the concentration of glycol, corrosion inhibitors, pH, reserve alkalinity and trace chemicals.

.5 Provide identification materials and system nameplates.

1.2 Quality Assurance

.1 All applicable codes shall be adhered to in the transportation, use, storage and disposal of the heat transfer fluid.

.2 All system components in contact with the inhibited glycol based heat transfer fluid in normal use, testing repair or servicing, including but not limited to pumps, valves, gaskets, seals, o-rings, etc. shall be fully compatible with the solution of heat transfer fluid at the temperatures and pressures used in the systems. Fully compatible means free from corrosion within the limits of the American Society for Testing and Materials (ASTM) D1384, free from erosion and scaling, free from fluid leaks, capable of performing the stated or implied function without binding, sticking or plugging, free from degradation of system materials, leaching of the system materials or degradation of the glycol solution and the inhibitors.

.3 Commercially available automotive antifreeze solutions are not acceptable.

.4 After installation and circulation of the glycol mixture, a representative sample shall be sent to the Manufacturer for analysis. The analysis results will be returned to the Contract Administrator.

.5 Annual analysis of the fluid will be provided by the Manufacturer, free of charge, to insure fluid quality. Recommendations for adjustment if necessary, will be made at that time.

1.3 Submittals

.1 Product data to include the percentage of volume of glycol and the following fluid properties: thermal conductivity, density, viscosity and specific heat.

.2 The Manufacturer of the fluid must supply written documentation in the submittal package for compliance to the corrosion standards of ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

.3 A Manufacturer's certificate of analysis that guarantees the content of the delivered Product shall be furnished with the inhibited glycol and presented to the Contractor at the time of delivery. A copy shall be forwarded to the Contract Administrator.

2. PRODUCTS

2.1 Fluid Material

.1 Provide a 30% by volume solution of industrial grade inhibited ethylene glycol based heat transfer fluid. The concentration shall not be less than 25% glycol by volume, with the balance being good quality water.

.2 The fluid must be easily analyzed for glycol concentration and inhibitor level, and easily reinhibited using replacement inhibitor available from the fluid Manufacturer.

.3 An annual analysis must be provided free of charge by the fluid Manufacturer. The analysis shall report glycol concentration, freeze point temperature, inhibitor level, pH, reserve alkalinity, contaminants such as: chlorine, sulphate, nitrate and total hardness. Recommendations on additions of glycol or inhibitors shall also be given as needed.

.4 The fluid must pass ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

2.2 Dilution Water

.1 The water used to dilute the concentrated inhibited glycol based heat transfer fluid must be either distilled, de-ionized or contain less than 25 ppm each of chloride or sulphate and less than 50 ppm each of hard water ions (calcium and magnesium as calcium carbonate) with a total hardness not to exceed 100 ppm. If good quality water is unavailable, the Manufacturer of the Product will provide the heat transfer fluid and water to meet the Specifications of the systems.

3. EXECUTION

3.1 System Preparation

.1 The system shall be cleaned and flushed prior to the installation of the industrially inhibited glycol based heat transfer fluid to remove dirt, weld slag, filings, solder flux, oil, etc. A new or mildly corroded system shall be cleaned with a 1% to 2% solution of trisodium phosphate in water, or another approved cleaning solution. This cleaning solution shall be circulated for eight (8) to twelve (12) hours and then flushed from the systems.

.2 The system shall be flushed with clean water and circulated for a minimum of seventy-two (72) hours, at which time a sample shall be taken to verify that the system is free of particulates, mil scale, weld scale, solder flux, rust, metal filings, oil, grease, chlorides, sulphates, silicates and other foreign matter that could degrade the inhibited glycol based heat transfer fluid.

.3 If water in the system is not acceptable, the water in the system shall be drained and the systems filled with water meeting the water quality requirements of this Section. If the manufacturer is supplying both fluid and water, the systems may be filled with the fluids upon removal of the flush water.

3.2 Fluid Installation

.1 The system is to be hydrostatically tested to insure that there are no leaks. The flush water may be used for the testing. Refer to Section 15030 – Testing.

.2 The Contractor shall provide a water meter to measure the volume of flush water put into the system. The total volume of the system is needed to determine the amount of inhibited heat transfer fluid required to meet the specified glycol concentration for the system. The Contractor is responsible disposal of glycol or water overages.

.3 A refractometer shall be provided by the Contractor and left with the City. The refractometer shall be used to measure the freezing point in degrees Fahrenheit of the inhibited glycol/water solution in the system. Standard of acceptance: Misco.

.4 The Contractor shall take a fluid sample with the Manufacturer's supplied test kit after the system has been circulating for a minimum of twenty-four (24) hours. The Manufacturer shall provide a thermal fluid analysis report to the Contract Administrator in writing. The Contractor shall be responsible to complete any changes in the heat transfer solution if it does not meet with these Specifications.

3.3 Identification Materials

.1 The Contractor will provide a system nameplate permanently encased in clear plastic with, but not limited to, the following information:

- Date
- Description of heat transfer fluid
- Manufacturer's name, address, telephone number and fax number for normal and emergency contact
- Percent glycol by volume
- Freeze point
- Total system volume in Litres
- Reference of the Material Safety Data Sheet (MSDS)
- Instruction for sampling
- The address to which the sample can be sent

Include a notation that proper inhibitor monitoring and maintenance must be performed (via annual analysis by the Manufacturer) in order to prevent corrosion of the piping system components, degradation of piping system materials, degradation of the glycol, sludge formation in the system, or freezing of the solution.

END OF SECTION

EXPANSION COMPENSATION

1. GENERAL

1.1 Scope

.1 Flexible pipe connections.

.2 Expansion joints and compensators in pipe systems.

.3 Pipe loops, offsets, and swing joints.

1.2 Reference Standard

.1 Conform to current Standards of "Expansion Joint Manufacturers Association" and Manufacturer's recommendations.

1.3 Shop Drawings

.1 Provide Shop Drawings for all equipment in this Section.

.2 Flexible pipe connector Shop Drawing data shall include maximum allowable temperature and pressure rating, overall face-to-face length, live length, hose wall thickness, hose convolutions per 300 mm (12 in.) and per assembly, fundamental frequency of assembly, braid structure and total number of wires in braid.

.3 Expansion joint Shop Drawings shall include maximum allowable temperature and pressure rating, and maximum expansion compensation.

1.4 Inspection

.1 Provide inspection services by flexible pipe Manufacturer's Representative for final installation and certify installation is in accordance with Manufacturer's recommendations and connectors are performing satisfactorily.

2. PRODUCTS

2.1 Flexible Pipe Connectors

.1 Flexible Rubber Spools: Neoprene twin sphere connector of molded multiple plys of nylon tire cord fabric and neoprene, rated for 1035 kPa (150 psi) at 120°C (250°F). Union end connections for sizes 50 mm (2 in.) and under; floating galvanised ductile iron flanges for sizes over 50 mm (2 in.).

.2 Spherical Rubber Spools: Neoprene single sphere elbow connector, construction and service rating same as 2.1.1. above.

.3 Braided Spools for Copper Piping: Stainless steel inner core and braid braized to copper tube ends, suitable for 1035 kPa (150 psi) at 120°C (250°F).

.4 Braided Spools for Steel Piping: Stainless steel inner core and braid welded to steel pipe nipples, threaded for pipe up to 50 mm (2 in.) diameter, flanged for 65 mm (2½ in.) diameter pipe and over. Suitable for service at 1035 kPa (150 psi) at 120°C (250°F).

2.2 Expansion Joints

.1 Copper Piping: Laminated stainless steel bellows brazed to copper tube ends, internal guide, stainless steel external shroud. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

.2 Steel Piping up to 100 mm (4 in.): Laminated stainless steel bellows welded to steel pipe nipples. Anti-torque device and threaded ends for sizes to 50 mm (2 in.), flanged ends for sizes 65 mm (2½ in.) and over. Internal guide and carbon steel shroud suitable for 1035 kPa (150 psi) at 260°C (500°F).

.3 Steel Piping 100 mm (4 in.) and over: Guided externally pressurised laminated stainless steel bellows, flanged ends, internal guide tube and ring, external shroud and guide ring. Suitable for 1035 kPa (150 psi) at 260°C (500°F).

2.3 Pipe Guides

.1 Four finger "spider" inside a guiding sleeve formed of two halves suitable for clamping onto pipe.

.2 Guided sleeve formed of two parts, suitable to be bolted to supporting structure.

.3 Guide length to be minimum 300 mm (12 in.).

3. EXECUTION

3.1 Application

.1 Provide flexible pipe connectors on pipes connected to equipment supported by vibration isolation and where indicated on the Drawing.

.2 Provide structural Work and equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide expansion joints where indicated or required. Where deemed necessary by the Contract Administrator the Contractor shall, at his own cost, employ a structural consultant to design pipe anchors to control piping expansion and contraction.

.3 Provide pipe guides as required to ensure correct pipe alignment for expansion joints.

3.2 Installation

.1 Install flexible connectors at right angles to displacement. Install one (1) end immediately adjacent to isolated equipment and anchor other end.

.2 Rigidly anchor pipe to building structure at points shown, and where necessary provide pipe guides so that movement takes place along axis of pipe only.

.3 Install flexible connectors and expansion joints in accordance with Manufacturer's instructions.

.4 Do not compress or expand connector during installation.

END OF SECTION

TANKS

1. GENERAL

1.1 Scope

.1 Expansion tanks.

.2 Saddles and structural supports.

.3 Provide Shop Drawings for all scheduled tanks.

1.2 Standards

.1 Construct pressure tanks to current American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels.

.2 Comply with current Provincial Government Regulations.

1.3 Submittals

.1 Provide Shop Drawings for all tanks specified.

2. PRODUCTS

2.1 Expansion Tanks, Diaphragm Type

.1 Welded steel, rated for working pressure, supplied with steel support structure.

.2 Precharged air chamber, heavy duty butyl diaphragm bonded with polypropylene liner to steel sheel separating air chamber from water.

.3 Provide with air side charge connection, and water side inlet connection precharged as scheduled.

3. EXECUTION

3.1 Installation

.1 Support tanks inside building from building structure as indicated on Drawings. Provide 100 mm (4 in.) high housekeeping bases on floor mounted tanks.

3.2 Performance

.1 Provide tanks of dimensions and capacities as indicated on tank schedules.

END OF SECTION

HEAT EXCHANGERS

1. GENERAL

1.1 Scope

.1 Heat exchanger.

.2 Relief and drain valves.

.3 Instrumentation.

.4 Insulation.

.5 Piping connections.

.6 Steel supports.

1.2 Quality Assurance

.1 Design and construction shall meet requirements of American Society of Mechanical Engineers (ASME) code for unfired pressure vessels and provincial codes.

1.3 Submittals

.1 Shop Drawings shall include dimensions, locations and size of tappings, and performance data to match Specification.

2. PRODUCTS

2.1 General

.1 Units shall be suitable for 861 kPa (125 psi) working pressure and 150°C (302°F) working temperatures.

.2 Heads shall be cast iron or steel, with steel or bronze tube sheets, threaded or flanged for piping connections.

.3 Water chamber and tube bundle shall be removable for inspection and cleaning.

.4 Prime coat exterior of units.

2.2 Shell And Tube Heat Exchanger

.1 Shell shall be steel, with threaded or flanged piping connections and necessary tappings.

.2 Tubes shall be 20 gauge copper.

.3 Provide steel saddle supports and attaching U-bolts.

.4 Units shall be designed for heating fluid in shell and heated fluid in tubes.

.5 Provide for temperature regulator sensor at heated fluid outlet.

.6 Provide ASME rated pressure and temperature relief valve on the heated fluid side.

.7 Provide thermometers and pressure gauge tappings in fluid inlets and outlets.

.8 Provide ASME rated pressure relief valve on steam side.

.9 Provide valved shell drain and vent.

3. EXECUTION

3.1 Installation

.1 Provide welded structural steel stands for floor mounting of heat exchangers. Bolt stand to floor.

.2 Ensure installation permits removal of tubes without disturbing installed equipment or piping.

.3 Refer to Drawings for details of installation and piping connections.

3.2 Heat Exchanger Schedule

.1 Refer to equipment schedule.

END OF SECTION

PIPING INSULATION

1. GENERAL

1.1 Scope

.1 Piping insulation.

.2 Adhesives, tie wires, tapes.

.3 Recovering.

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet or exceed fire and smoke hazard ratings as stated in this Section and defined in applicable building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating and recovering materials.

1.4 Job Conditions

.1 Deliver material to job Site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive Manufacturer. Make good separation of joints or cracking of insulation due to thermal movement or poor workmanship.

1.5 Alternatives

.1 Alternative insulations are subject to review and acceptance by the Contract Administrator. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Materials, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

.3 Insulate fittings and valve bodies with preformed removable insulated fittings.

2.2 Materials

.1 Cold Piping: Formed fine fibrous glass or formed mineral fibre pipe insulation, with factory applied vapour barrier jacket, factory moulded to conform with piping, "K" value at 24°C (75°F) maximum 0.035 W/m.°C (0.25 Btu-in/hr-ft^2-°F). Service temperature -14°C (7°F) to 100°C (212°F).

.2 Roof Drain Piping and Plumbing Vents: Formed fine fibrous glass or formed mineral fibre pipe insulation, with factory applied vapour barrier jacket, factory moulded to conform with piping, "K" value at 24°C (75°F) maximum 0.035 W/m.°C (0.25 Btu-in/hr-ft^2-°F). Service temperature -14°C (7°F) to 100°C (212°F).

.3 Hot Piping: Formed fine fibrous glass or mineral fibre pipe insulation, with factory applied general purpose jacket, factory moulded to conform to piping, "K" value maximum 0.035 W/m.°C (0.25 Btu-in/hr-ft^2-°F) at 24°C (75°F). Service temperature up to 150°C (300°F).

.4 Recovery Jackets:

.1 Polyvinyl Chloride (PVC):

.1 One-piece moulded type and sheet to Canadian Standards Association/Canadian Government Specification Board (CAN/CGSB)-51.53 with pre-formed shapes as required.

.2 Colours: white.

.3 Service temperatures: minimum -4°F, maximum 150°F.

.4 Moisture vapour transmission: 0.02 perm.

.5 Thickness: 20 mils.

.6 Fastenings: Use solvent weld adhesive compatible with insulation to seal laps and joints.

.2 Aluminum:

.1 To American Society for Testing and Materials (ASTM) B 209.

.2 Thickness: 30 gauge for piping.

.3 Finish: Stucco embossed.

.4 Joining: Longitudinal and circumferential slip joints with 2 inch laps.

.5 Fittings: Die-shaped fitting covers with factory-attached protective liner.

.6 Metal jacket banding and mechanical seals: stainless steel, 3/4 inches mm wide, at 12 inch spacing.

3. EXECUTION

3.1 Preparation

.1 Do not install covering before piping and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around pipes with fire proof self-supporting insulation material, properly sealed.

.2 Insulate complete system including fittings, valves, unions, flanges, strainers. Do not insulate flexible connections and expansion joints. Terminate insulation neatly with plastic material travelled on a bevel.

.3 Insulate piping, fittings and valves. Do not insulate unions, flanges (except on flanged valves), "victaulic" couplings, strainers, (except on chilled water lines), flexible connections and expansion joints. Terminate insulation neatly with plastic material trowelled on a bevel.

.4 Finish insulation neatly on hangers, supports and other protrusions.

.5 Locate insulation or cover seams in least visible locations. Locate seams on piping in ceiling spaces on the underside of the pipe.

.6 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, pipe shafts and suspended ceiling spaces is not considered exposed. Make smooth uneven insulated surfaces before recovering.

.7 Cold Piping: Seal lap joints with 100% coverage of vapour barrier adhesive. Seal butt joints with 50 mm (2 in.) wide strips of vapour barrier sealed with vapour barrier adhesive. For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells, seal all laps and joints.

.8 Flare out staples may be used to secure jacket laps on hot systems. Staples are to be applied on 100 mm (4 in.) centres.

.9 Hot Piping: For fittings and valves, apply hydraulic insulating cement; or apply factory fabricated insulation half shells.

3.3 Insulation Installation Thickness Schedule

	Piping or Equipment	Pipe Sizes mm (in.)	Insulation Thickness mm (in.)	Recovery Jacket
.1	Chilled Glycol Piping	All sizes	25 (1)	PVC
.2	Domestic Cold Water Piping	15 to 20 (½ to ¾) 25 (1) & over	15 (½) 25 (1)	PVC
.3	Domestic Hot Water Supply and Recirculation Piping	15 (½) to 50 (2) Over 50 (2)	25 (1) 40 (1½)	PVC
.4	Glycol Heating Piping	All sizes	40 (1½)	PVC
.5	Roof Drains and complete storm drainage piping within building	All sizes	25 (1)	PVC
.6	Vents within 3 m (10 ft) of Roof Outlet, as measured along pipe	All sizes	25 (1)	PVC
.7	Air Separators		25 (1)	Aluminum
.8	Condenser Glycol Piping (indoors)	to 25 (1) 30 (1¼) to 150 (6) 200 (8) & over	25 (1) 40 (1½) 50 (2)	PVC

Note: Pipe insulation for piping installed in 38 mm x 92 mm (2 in. x 4 in.) (2 x 4) wall cavity can be reduced 15 mm (1/2 in.), for pipe sizes 40 mm (1 1/2 in.) to (65 mm 2 1/2 in.). Install insulation to thickness specified piping outside the wall cavity.

END OF SECTION

DUCT INSULATION

1. GENERAL

1.1 Scope

.1 Duct thermal insulation.

.2 Duct acoustic insulation.

.3 Adhesives, tie wires, tapes.

.4 Recovery.

.5 All outdoor mounted ductwork.

1.2 Quality Assurance

.1 Insulation shall be installed by skilled workmen regularly engaged in this type of Work.

.2 Materials shall meet fire and smoke hazard ratings as stated in this Section and defined in applicable current building codes.

1.3 Submittals

.1 Submit Shop Drawings which indicate complete material data, "K" value temperature rating, density, finish, recovery jacket of materials proposed for this project and indicate thickness of material for individual services.

.2 Submit samples of proposed insulating materials and recovering.

1.4 Job Conditions

.1 Deliver material to job Site in original non-broken factory packaging, labelled with Manufacturer's density and thickness.

.2 Perform Work at ambient and equipment temperatures as recommended by the adhesive Manufacturer. Make good separation of joints or cracking of insulation due to thermal movement, poor workmanship or material defects.

1.5 Alternatives

.1 Alternative insulations are subject to approval. Alternatives shall provide the same or better thermal resistance at normal conditions as material specified.

2. PRODUCTS

2.1 General

.1 Insulation Material, Recovery Jackets, Vapour Barrier Facings, Tapes and Adhesives: Composite fire and smoke hazard ratings shall not exceed 25 for flame spread and 50 for smoke developed.

.2 Insulating materials and accessories shall withstand service temperatures without smouldering, glowing, smoking or flaming.

.3 Recovery Jackets:

.1 Aluminum:

.1 To American Society for Testing and Materials (ASTM) B 209.

.2 Thickness: 30 gauge for piping.

.3 Finish: Stucco embossed.

.4 Joining: Longitudinal and circumferential slip joints with 50 mm (2 inch) laps.

.5 Fittings: Die-shaped fitting covers with factory-attached protective liner.

.4 Metal jacket banding and mechanical seals: stainless steel, 19 mm (3/4 inches) wide, at 300 mm (12 inch) spacing. All insulation materials shall meet current Building Code Standards, and packages or containers of such materials shall be appropriately labelled.

2.2 Materials

.1 Exposed Rectangular Ducts: Rigid fibrous glass or mineral fibreboard insulation, "K" value maximum 0.035 W/m.°C (0.25 BTU-in/hr.ft^2.°F) at 24°C (75°F). Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C (68°F) to 65°C (150°F). Cold ducts service temperature -40°C (-40°F) to 65°C (150°F).

.2 Round Ducts and Concealed Rectangular Ducts: Flexible fibrous glass or mineral fibre insulation, "K" value maximum 0.035 W/m.°C (0.25 BTU-in/hr.ft^2.°F) at 24°C (75°F). Factory applied reinforced aluminum foil vapour barrier for cold ducts. Hot duct service temperature 20°C (68°F) to 65°C (150°F). Cold duct service temperature -40° (-40°F) to 65°C (150°F).

.3 Acoustic Lining: Fibrous glass or mineral fibreboard insulation with "K" value maximum 0.035 W/m.°C (0.25 BTU-in/hr ft^2°F) at 24°C (75°F). Absolute roughness of exposed surface not to exceed 0.58 mm (0.02 in.), coated to prevent fibre erosion at air velocities up to 25.4 m/s (5,000 fpm), 24 kg/m^3 (1.5 lb/ft^3) minimum density for ductwork and 75 kg/m^3 (4.7 lb/ft^3) for plenums. Substrate must not be dark in colour. Service temperature -40°C (-40°F) to 65°C (150°F).

3. EXECUTION

3.1 Preparation

.1 Do not install covering before ductwork and equipment has been tested and approved.

.2 Ensure surface is clean and dry prior to installation. Ensure insulation is dry before and during application. Finish with systems at operating conditions where possible.

3.2 Installation

.1 Ensure insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation materials, properly sealed.

.2 Finish insulation neatly at hangers, supports and other protrusions.

.3 Do not insulate ductwork with external thermal insulation where acoustic duct insulation is specified.

.4 Locate insulation or cover seams in least visible locations. Locate seams on ductwork in ceiling spaces on the underside of the duct.

.5 Provide recovering jackets on exposed insulation throughout, including equipment rooms. Insulation located in crawl spaces, shafts and suspended ceiling spaces is not considered exposed. Make smooth any uneven insulated surface before recovering.

.6 Cover insulation exposed to outdoors with aluminum jacket secured with aluminum bands on 200 mm (8 in.) centres or screws on 150 mm (6 in.) centres. Lap joints 75 mm (3 in.) minimum and seal with compatible waterproof lap cement.

.7 Exposed Rectangular Ducts: Secure rigid insulation with galvanised anchors or welded pins on 400 mm (16 in.) centres. Secure in place with retaining pins. Seal all insulation joints and breaks with joint tape. Seal adhesive; cover joints with 100 mm (4 in.) strips of open mesh cloth imbedded between two coats of lap seal adhesive. Use vapour barrier tape for insulation joints or breaks on cold ducts.

.8 Round Ducts and Concealed Rectangular Ducts: Adhere flexible insulation to ductwork with adhesive applied in 150 mm (6 in.) wide strips on 400 mm (16 in.) centres. Provide annealed tie wire tied at 400 mm (16 in.) centres for securing duct insulation. Butt insulation and seal joints and breaks with lap seal adhesive; cover joints with joint tape. Use vapour barrier tape for cold ducts.

.9 Acoustic Lining: Apply to interior of ducts where shown. Secure to ductwork with adhesive using 50% coverage and anchors or weld pins on 400 mm (16 in.) centres. Secure in place with retaining clips. Cut off excess fastener length and cover with brush coat of mastic over protrusions and all raw edges. Use 25 mm (1 in.) thick insulation unless otherwise noted. Provide vapour barrier located on the warm side for outside air intakes. Bevel corners at

joints and butt together. Install acoustic gauze over all cut corners and joints and brush coat with lap seal adhesive.

.10 Where duct velocities exceed 15 m/s (3,000 fpm), cover internal duct insulation with 0.8 mm (22 ga) perforated galvanised steel with 24% free area.

.11 Fasten aluminum recovery jacket in place with aluminum banding on 200 mm (8 in.) centres or screws or rivets on 150 mm (6 in.) centres.

3.3 Insulation Installation Thickness Schedule

	Ducts and Equipment	Insulation Thickness mm (in.)	Recovery Jacket
.1	Relief Duct	50 (2)	Foil Face
.2	Exhaust Ducts within 3000 mm (10 ft) of Exterior Walls or Openings	25 (1)	Foil Face
.3	Outside Air Intake Ducts	50 (2)	Foil Face
.4	Plenums (Heating Systems)	50 (2)	--
.5	Plenums (Systems with Cooling Coils)	50 (2)	--
.6	Supply Ducts Heating/Cooling System	25 (1)	Foil Face
.7	Ducts Exposed to Outdoors	50 (2)	Aluminum
.8	Acoustic Lining (where indicated)	25 (1)	--

END OF SECTION

1. GENERAL

1.1 Scope

.1 All pumps except where integral with a manufactured piece of equipment.

.2 Pumps controls where self contained.

1.2 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Submit with Shop Drawings certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include net positive suction head (NPSH) curve when applicable. Show pump weights, motor and pump operating or efficiencies and electrical power characteristics.

1.3 Quality Assurance

.1 Pumps shall be aligned by qualified millwright and alignment certified.

.2 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25% of midpoint of published maximum efficiency curve.

.3 Motors shall be high efficiency and/or inverter only as specified in Section 15010.

1.4 Related Work and Documents

.1 Division 1.

.2 Division 16.

.3 Division 17.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance rotating parts.

.2 Construction shall permit complete servicing without breaking piping or motor connections.

.3 Pumps shall operate at 1,800 rpm unless specified otherwise.

.4 Pump connections shall be flanged.

2.2 Closed Couple Pump

.1 Type: Centrifugal, closed couple, single stage, vertical split case design.

.2 Casing: Class 30 cast iron volute, end suction rated for 1.2 MPa (175 psi) working pressure. The casing shall have gauge ports, vent and drain ports.

.3 Impeller: Cast bronze, fully enclosed, statically and dynamically balanced, keyed to shaft and secured by a locking screw.

.4 Shaft: Steel.

.5 Seals: Internal self-flushing mechanical seal with ceramic seal seat of at least 98% alumina oxide content and carbon seal ring, suitable for continuous operation at 107°C (225°F). A replaceable shaft sleeve of bronze alloy shall completely cover the wetted area under the seal.

.6 Motors: Open drip proof, unless noted otherwise in pump schedule.

.7 Finish: High grade machinery enamel.

2.3 Shallow Well Jet Pumps

.1 Type: Centrifugal, multistage, self-priming.

.2 Casing: Cast iron, threaded suction and discharge.

.3 Impeller: Noryl.

.4 Ejector/Guide Vane: Noryl.

.5 Shaft: Stainless steel.

.6 Drive: Direct coupled.

.7 Seals: Noryl.

.8 Motor Plate: Cast iron.

.9 Motor: TEFC, 3400 rpm.

2.4 Self-Priming Centrifugal Pump

.1 Type: Horizontal, self-priming centrifugal type.

.2 Casing: Cast iron, back pullout design. Casing shall incorporate following features:

.1 Mounting feet sized to prevent tipping or binding when pump is completely disassembled for maintenance.

.2 Integral steel-weighted, rubber moulded check valve

.3 Casing drain plug.

.4 Taps for pressure and vacuum gauges on the suction inlet, discharge outlet and the volute casing.

.5 The suction and discharge connections shall be threaded (NPT).

.3 Rotating Assembly: A rotating assembly, which includes impeller, shaft, mechanical shaft seal, lip seals, bearings, seal plate and bearing housing must be removable as a single unit without disturbing the pump casing or piping. Design shall incorporate following features:

.1 Seal plate and bearing housing shall be cast iron. Separate oil filled cavities, vented to atmosphere, shall be provided for shaft seal and bearings. Cavities must be cooled by the liquid pumped and lip seals will prevent leakage of oil. The bearing cavity to have an oil level sight gauge and fill plug check valve. The check valve shall vent the cavity but prevent introduction of moist air to the bearings.

.2 Impeller shall be ductile iron, two-vane, semi-open, non-clog, with integral pump out vanes on the back shroud. Impeller shall thread onto the pump shaft and be secured with a lockscrew and conical washer.

.3 Diffuser: cast iron.

.4 Shaft: steel.

.5 Bearings shall be anti-friction ball or tapered roller type of proper size and design to withstand all radial and thrust loads expected during normal operation. Bearings shall be oil lubricated from a dedicated reservoir.

.6 Shaft seal shall be oil lubricated mechanical type.

.4 Motors:

.1 Refer to Specification Section 15010.

.2 Pump motors shall be horizontal, open drip proof, 1,750 RPM, Electrical & Electronic Manufacturer's Association of Canada (EEMAC) design B with cast iron frame with copper windings, induction type, with class F insulation and 1.15 Service Factor for normal starting torque and low starting current characteristics, suitable for continuous service. The motors shall not overload at the design condition or at any head in the operating range as specified.

.5 Drive Transmission:

.1 Flexible coupling with coupling guard.

.6 Baseplate: High grade heat treated cast iron or reinforced heavy steel.

2.5 In-Line Circulator

.1 Materials of construction:

.1 Stainless steel: Inlet cone, bearing plate and retainers, rotor can, rotor cladding, shaft retainer and impeller.

.2 Aluminium: Stator housing.

.3 Aluminium oxide ceramic: Shaft and upper and lower radial bearings.

.4 Metal impregnated carbon: Thrust bearing.

.5 Cast iron: Volute.

.6 Ethylene propylene rubber: O-ring and gaskets.

3. EXECUTION

3.1 Installation

.1 Provide drains for bases and stuffing boxes piped to and discharging into floor drains.

.2 Provide domestic water and drain for seal flush water heat exchangers. Pipe to nearest floor drain.

.3 Provide air cock and drain connection on horizontal pump casings.

.4 Decrease from line size, with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 100 mm (4 in.) and over.

.5 Check and align pumps prior to start-up.

3.2 Performance

.1 Refer to the Pump Schedule.

END OF SECTION

RECIPROCATING AIR COMPRESSORS

1. GENERAL

1.1 Scope

.1 Package reciprocating air compressors.

.2 Air Dryers.

1.2 Quality Assurance

.1 Ensure compressors operate at specified air volume without oil creep, are non-overloading and operate within 10% of peak efficiency.

.2 Air receivers shall meet requirements of American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels and carry ASME approval stamp.

1.3 Submittals

.1 Submit provincial inspectors certificate for air receiver for inclusion in Operating and Maintenance (O&M) Manuals.

.2 Submit full Shop Drawings for all equipment and accessories in this Section.

2. PRODUCTS

2.1 Packaged Air Compressor – Reciprocating Type

.1 General

.1 Two stage, air-cooled, reciprocating, vertical, tank-mounted, V-belt driven.

.2 Compressor Construction

.1 Construct compressor unit with cast iron housing, head, cylinder and flywheel, heat treated forged steel or ductile iron shaft, aluminum alloy connecting rods, cast iron pistons with non-lubricated carbon rings, high strength alloy suction and discharge valves. Lapped cast iron valve seats. Statically and dynamically balance rotating parts.

.2 Pressure lubricated with positive displacement oil pump and spin on oil filter. Equip compressor with oil pressure switch to automatically shut down compressor in event of oil pressure failure.

.3 Provide compressor with automatic capacity reduction equipment consisting of suction valve unloaders. Lifting mechanism shall be operated by oil pressure. Provide for unloaded compressor start.

.4 Copper tube intercooler between stages with large circular fins.

.5 Mount motor with provision for V-belt adjustment and compressor on steel base.

.6 Provide belt guards on all compressors.

2.2 Air Dryer

.1 Provide refrigerated air dryer of self-contained mechanical refrigeration type complete with heat exchanger, refrigeration compressor, automatic controls, moisture removal trap, internal wiring and piping and full refrigerant charge.

.2 Design so air inlet and air outlet connections are at same level and factory insulated.

.3 Heat exchangers to consist of air to air and refrigerant to air coils. Provide centrifugal type moisture separator located at discharge of heat exchanger. Provide heat exchangers with automatic control system to bypass refrigeration system on low or no load condition.

.4 Refrigeration unit shall be hermetically sealed type to operate continuously to maintain specified -6°C (21°F) dew point. House unit in steel cabinet provided with access door and panel for maintenance and inspection.

.5 Dryer shall be provided with air inlet temperature gauge, air inlet pressure gauge, on/off switch, high temperature light, power on light, refrigerant gauge, air outlet temperature gauge, air outlet pressure gauge.

2.3 Air Receiver

.1 Provide horizontal receiver built to Canadian Standards Association (CSA) B51, American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) Section VIII and provincial regulations for working pressure of 860 kPa (125 psi). Flange or screw inlet and outlet connections.

.2 Fittings shall include adjustable pressure regulator, safety valve, pressure gauge, drain cock and automatic condensate trap.

.3 Tank finish shall be shop primed and painted.

2.4 Controls

.1 Pressure switch shall operate to cut out 690 kPa (100 psi) with a minimum differential of 140 kPa (20 psi).

.2 Provide HOA starter switch.

3. EXECUTION

3.1 Installation

.1 Install compressor unit on housekeeping pad. Level, grout and bolt in place.

.2 Provide air cock and drain connection on horizontal casing.

.3 Provide line size valve and anti-return valve on compressor discharge.

.4 Provide replaceable cartridge type filter silencer of adequate capacity.

.5 Provide shut-off valve on water inlet to aftercooler. Pipe drain to floor drain.

.6 Connect condensate drains to nearest floor drain.

.7 Provide valved drip connections at low points of piping system.

.8 Install take-offs to outlets from top of main, with shut-off valve after take-off.

.9 Provide compressed air couplings, 10 mm (3/8 in.) female speed couplers, and pressure gauges where outlets are indicated.

.10 Provide tee pieces in lieu of elbows at changes in direction of piping. Fit open end of each tee with plug.

3.2 Performance

.1 Refer to schedule for air compressors.

.2 Refrigerated air dryers shall have capacity to dry air to an atmospheric dew point 1.6°C (35°F) at the rated air flow 4.7 L/s (10 cfm) at 690 kPa (100 psi) inlet air pressure. Pressure differential from inlet to outlet shall not exceed 34.5 kPa (5 psi). Standard of acceptance: Zeks model 10NCC. Typical of two.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Cleanouts.

.2 Air chambers or water hammer arresters.

.3 Roof and floor drains.

.4 Cooling equipment condensate drains.

.5 Domestic water heaters.

.6 Sanitary sewer service connections.

.7 Water service connections.

.8 Backflow preventers.

.9 Vacuum breakers.

.10 Backwater valves.

1.2 General Requirements

.1 Provide materials, equipment and labour to install plumbing as required by Provincial and Local Codes and as specified herein.

.2 Provide water and drainage connections to equipment furnished in other Sections of this Specification and as supplied by the City.

.3 Provide an approved water meter and bypass installation conforming to Local Codes and Standards.

.4 Provide and include charges for connections to Municipal and Utility Company Service.

1.3 Submittals

.1 Submit Shop Drawings for review by the Contract Administrator, in accordance with the General Conditions. Provide Shop Drawings for the following items:

- Roof Drains
- Floor Drains
- Domestic Water Heaters
- Backflow preventers

- Vacuum Breakers

2. PRODUCTS

2.1 Clean-Outs and Clean-Out Access Covers

.1 Provide caulked or threaded type extended to finished floor or wall surface. Provide bolted coverplate clean-outs on vertical rainwater leaders only. Ensure ample clearance at clean-out for rodding of drainage system.

.2 Floor cleanout access covers in unfinished areas shall be round with nickel bronze scoriated frames and plates. Provide round access covers in finished areas with depressed centre section to accommodate floor finish. Wall cleanouts to have chrome plated caps.

2.2 Water Hammer Arresters

.1 Fit water supply to each fixture or group of fixtures with an air chamber. Provide air chambers same size as supply line or 20 mm (3/4 in.) minimum and minimum 450 mm (18 in.) long.

.2 Install stainless steel bellows type water hammer arresters on water lines connected to solenoid valves and to fixture or group of fixtures complete with accessible isolation valve.

2.3 Roof Drains

.1 Flow Characteristics: Full open flow.

.2 Material: All major components including body, flashing clamping flange, under deck clamping ring and dome strainer shall be cast iron or cast aluminum, lacquered. Bolts shall be galvanised or prime painted steel.

.3 Body:

.1 Sump: minimum 180 mm (7 in.) internal diameter, minimum 75 mm (3 in.) deep.

.2 Discharge: nominal 100 mm (4 in.) non-threaded MJ.

.3 Bosses: solid, integrally cast, for under deck clamping ring and flashing flange bolts.

.4 Deck flange: nominal 300 mm (12 in.) outside diameter, minimum 50 mm (2 in.) width.

.4 Flashing Clamping Flange: Outside diameter same as outside diameter of deck flange; V-notched positive draining gravel stop lip, 15 mm (1/2 in.) high.

.5 Dome Strainer: Minimum 150 mm (6 in.) high; 8 mm (0.3 in.) to 15 mm (1/2 in.) slotted openings, sides and top.

.6 Standard of acceptance: ‘Zurn’ model Z-121-C.

2.4 Floor Drains

.1 FD-1: Floor drain with heavy duty round strainer and clamping collar. Floor drain shall have lacquered cast iron body with bottom outlet, combination invertible membrane clamp, trap primer connection, sediment bucket and adjustable collar heavy-duty five-inch polished nickel bronze strainer. Extension adaptors provided as required. Washroom floor drains shall have a removable perforated sediment bucket. Standard of acceptance: 'Zurn' model ZX-415-A5-AR-P-Y.

.2 FD-2: Floor drains in equipment rooms shall be similar to FD-1, with 100 mm (4 in.) cast iron funnel type strainer.

2.5 Equipment Drains

.1 Provide a sloped connection from packaged equipment drain pans to nearest sanitary sewer trapped connection. Slope at minimum of 0.5% grade. Drains size to be 25 mm (1 in.) complete with 100 mm (4 in.) deep trap at unit.

2.6 Domestic Water Heaters

.1 Construct electric domestic water heaters to Canadian Standards Association (CAN/CSA) C22.2 No. 110. Heaters exceeding an input of 30 kW (100 MBH) or an inside diameter of 610 mm (24 in.) must also meet the requirements of Boiler and Pressure Vessel Safety Act.

.2 Refer to equipment schedules for specific selection.

2.7 Backflow Preventer Assemblies

.1 Provide backflow preventer assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall meet current American Water Works Association (AWWA) requirements and CSA B64 standards.

.2 Provide complete double check valve type assembly consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide check valve on units 50 mm (2 in.) and smaller. Watts No. 709.

.3 Provide complete atmospheric vent backflow preventer assembly, consisting of two (2) positive sealing replaceable check valves with bronze seats, integral stainer and threaded vent connection. Watts No. 9D.

2.8 Vacuum Breaker Assemblies

.1 Provide pressure type vacuum breaker assembly complete with shut-off valves before and after check valves and test cocks. Assembly shall consist of one (1) positive sealing check valve and one (1) atmospheric vent disk with stainless steel or bronze seats complete with shut-off valves before and after check valves and test cocks. Assembly shall meet AWWA requirements and CSA B64 standards. Watts No. 800.

.2 Provide atmospheric type vacuum breaker assembly complete with shut-off valve before assembly. Assembly shall consist of one (1) free floating poppet to seal the atmospheric vent under flow conditions. Watts No. 288A. For bottom inlet and outlet, Watts No. 388 ASC.

.3 Provide hose connection type vacuum breaker assembly, consisting of a check valve disc assembly to be vandal proof and drainable. Watts No. 8A. For freezing conditions, Watts No. NF8.

2.9 Trap Seal Primers

.1 Bronze automatic trap primer complete with sediment strainer, union and access door for concealed installations with 13 mm (1/2 inch) copper tubing connections between primer valve and floor drain.

3. EXECUTION

3.1 Installation

.1 Lubricate clean-out plugs with mixture of graphite and linseed oil. Prior to building turnover remove clean-out plugs, re-lubricate and reinstall using only enough force to ensure permanent leak proof joint.

.2 Install backflow prevention devices on plumbing lines, to code requirements, where contamination of domestic water may occur. Generally necessary on boiler make-up lines, hose bibbs and flush valves.

.3 Where floor drains are located over occupied areas, provide waterproof installation.

.4 Install trap primers on all floor drains.

.5 Drainage lines shall grade 2 mm per 100 mm (2 in per 100 in.) unless otherwise indicated on Drawings.

.6 Locate plumbing vents minimum 4.9m (16 ft.) from air intakes.

.7 Provide a heat trap loop in domestic hot water supply piping at domestic hot water storage tank.

3.2 Services

.1 Provide new sanitary connection to Site services. Before commencing Work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with sufficient slope for drainage and adequate cover to avoid freezing.

.2 Provide new water service complete with necessary thrust blocks on underground water piping as required and detailed. Provide sleeve in wall for service main and adequately

support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Securely anchor service main inside to concrete wall.

END OF SECTION

PLUMBING FIXTURES AND TRIM

1. GENERAL

1.1 Scope

.1 Plumbing fixtures and trim.

.2 Emergency eye/face wash and thermostatic mixing valve.

.3 Hose reel.

1.2 General Requirements

.1 Provide new fixtures, Canadian Standards Association (CSA) approved, free from flaws and blemishes with finished surfaces clear, smooth and bright.

.2 Provide CSA approved plumbing fittings. Visible parts of fixture brass and accessories shall be heavily chrome plated.

.3 Fixtures shall be Product of one (1) Manufacturer. Fittings of same type shall be of Product of one (1) Manufacturer.

.4 Protect fixtures against use and damage during construction.

1.3 Job Conditions

.1 Check millwork Shop Drawings. Confirm location and size of fixtures and openings before rough-in and installation.

1.4 Submittals

.1 Submit Shop Drawings for review.

2. PRODUCTS

2.1 Water Closet WC-1

.1 Bowl: Floor mounted vitreous china, siphon action, elongated rim bowl, low consumption combination (6.0 lpf at 80 PSI.), 430 mm (17 in) high, self draining jet, bolt caps, insulated vitreous china closet tank complete with fittings. Tank lid shall be secured to tank by bolting down or other approved method. Standard of Acceptance: Crane Hymont Model No. 31056.

.2 Seat: Solid white plastic, elongated seat, open back, open front, and stainless steel concealed check hinge. Olsonite Model No. 1050 CC.

2.2 Lavatory LV-1

.1 Lavatory: Vitreous china, wall hung lavatory with 115 mm (4½ in.) high integral back, rectangular basin, splash lid, front overflow, soap depressions, chrome plated supplies and stops, chrome adjustable "P-trap" with extension. Standard of Acceptance: Crane Harwich Model No. 1412V, complete with concealed arm carrier, Zurn Model No. Z1231.

.2 Trim: Two handle centreset, lavatory supply with grid strainer drain assembly, water economy aerator, 100 mm (4 in.) centres, quarter turn ceramic control components and wrist blade handles with red/blue indicators, 115 mm (4½ in) blade handle and 30 mm (1¼ in.) outlet connection. Symmons Symmetrix, Model No. S-240-2-G-LWG-FR.

2.3 Mop Sink MS-1

.1 Bowl: 600 mm x 600 mm x 250 mm deep precast terrazzo one piece, floor mounted sink with 50 mm wide shoulders, stainless steel caps on all curbs and stainless steel strainer. Standard of acceptance: Fiat Model No. TSB-3000.

.2 Trim: Exposed wall type supply with 267mm (10-1/2 in.) top brace spout, body mounted angle vacuum breaker, hose thread outlet, aerator, rigid pail hook, eccentric adjustable inlets, integral screwdrivers stops with covering caps and adjustable threaded wall flanges, 787 mm (31 in.) of 15 mm (1/2 in.) plain end reinforced rubber hose, hose clamp, stainless steel mop hanger, 70mm (2-3/4 in.) level blade handles. Trim to be mounted 900 mm (36 in.) up off the floor. Standard of acceptance: Cambridge Brass Model No. 28T2393.

2.4 Eyewash EW-1

.1 Eyewash: Barrier-free wall mounted eye/face wash with 275mm (11 in.) stainless steel receptor, stainless steel wall bracket, Acrylonitrile, Butadiene, and Styrene (ABS) plastic eye/face wash heads with built-in 9.5 L/min (2.5 gpm) flow control with integral flip top dust cover, stainless steel eyewash yoke, waste tailpiece, trap, 15 mm (1/2 in.) IPS, 40 mm (1-1/2 in.) waste, emergency eyewash sign, 16 gauge Type 304 stainless steel wall mounted bracket, ‘Test This Week’ waterproof test card. Standard of Acceptance: Haws Model No. 7360BTEC.

2.5 Thermostatic Mixing Valve MV-1

.1 Mixing Valve: Self-contained, including a primary and a secondary thermostatic water mixing valve, dial thermometer on outlet, union angle strainer check stops, wall mounting bracket, fittings factory assembled and tested, top inlets and outlet, unit wet for 29ºC (85ºF), and a maximum temperature of 32ºC (90ºF). Unit must be able to be set to the correct temperature for the specific contaminant but must be locked in place to prevent changing of the temperature by accident. Unit must be checked weekly for performance in conjunction with the requirements of American National Standards Institute (ANSI) Z-358. Unit shall maintain temperatures with the acceptable range to a minimum flow of 1.9 L/min (0.5 gpm). Standard of Acceptance: Leonard Model No. TA-350.

2.6 Hose Reel HR-1

.1 Hose Reel: Water medium, reel with 20 mm (3/4 in.) hose, 15 m (49 ft.) length, 1.2 MPa (170 psi) max. working pressure, pivoting wall bracket, ABS plastic covering. Standard of Acceptance: Nederman Ser. 884.

3. EXECUTION

3.1 Installation

.1 Install each fixture with its own trap, easily removable for servicing and cleaning. At completion thoroughly clean plumbing fixtures and equipment.

.2 Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers and escutcheons.

.3 Install wall mounted lavatories with approved wall carriers.

.4 Caulk gap between mop sink and wall with silicone sealant.

3.2 Fixtures Rough-In Schedule

.1 Rough-in fixture piping connections in accordance with the following table of minimum sizes.

	Hot Water	Cold Water	Waste	Vent
Lavatories	15 mm (½ in.)	15 mm (½ in.)	40 mm (1½ in.)	30 mm (1¼ in.)
Service Sink	15 mm (½ in.)	15 mm (½ in.)	50 mm (2 in.)	40 mm (1½ in.)
Floor Drains	--	--	100 mm (4 in.)	40 mm (1½ in.)
Water Closet (Tank Type)	--	15 mm (½ in.)	100 mm (4 in.)	50 mm (2 in.)

END OF SECTION

FIRE EXTINGUISHERS

1. GENERAL

1.1 Scope

.1 Fire extinguishers.

1.2 General Requirements

.1 Provide portable hand extinguishers where indicated on Drawings and specified herein.

1.3 Quality Assurance

.1 Fire protection equipment and installation shall be approved by local Fire Commissioner.

.2 Equipment and installation shall meet the requirements of National Fire Protection Association (NFPA) No. 10 Portable Fire Extinguishers – latest edition.

1.4 Submittals

.1 Submit Shop Drawings for review. Submit with Shop Drawings Material Safety Data Sheets (MSDS) for each chemical used in the Fire Extinguishers.

2. PRODUCTS

2.1 Portable Hand Fire Extinguishers

.1 Multi-Purpose Dry Chemical (Type 1): Pressurised with hose and shut-off nozzle or integral shut-off nozzle and mounting brackets 4.5 kg (10 lb.) capacity rating 4A:60BC.

.2 Carbon Dioxide (Type 3): Hose and horn discharge, self-closing lever or squeeze grip operated, insulated handle fully charge and complete with mounting brackets, 2.25 kg (5 lb.) capacity. Rating 5BC.

3. EXECUTION

3.1 Installation

.1 Install extinguishers so that the bottom of extinguisher is no more than 1200 mm (4 ft.) above floor.

3.2 Schedules

	Location	Fire Extinguisher	Cabinet Type	Size	Rating
.1	Corridor	Type 1	None	4.5 kg	4A:60BC
.2	Electrical	Type 3	None	2.25 kg	5BC
.3	UV Disinfection Floor	Type 1	None	4.5 kg	4A:60BC
.4	UV Disinfection Floor	Type 1	None	4.5 kg	4A:60BC
.5	Mech. Mezz.	Type 1	None	4.5 kg	4A:60BC

END OF SECTION

ELECTRIC HOT WATER BOILERS

1. GENERAL

1.1 Scope

.1 Provide one (1) electrically heated hot water boiler complete with standard equipment and options.

1.2 Quality Assurance

.1 Comply with Provincial Regulations and have Canadian Standards Association (CSA) approval.

.2 The boiler shall be constructed to the latest edition of the American Society of Mechanical Engineers (ASME) Code.

.3 Provide factory tests to check construction, controls and operation of unit.

1.3 Start-up

.1 Supply services of factory trained representative to start-up units and train operator.

.2 Provide start-up and Commissioning service, make adjustments, (test efficiency and instruct operators). Submit detailed start-up and Commissioning report complete with fuel gas analysis sheets.

1.4 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each piece of equipment, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include but not be limited to dimensions, weights, capacities, component performances, electronic characteristics, field connection details (indicating size and location), proposed test descriptions and sample reports, gauges, wiring diagrams, code compliance and finishes of materials.

.5 Submit Manufacturer’s recommended installation instructions.

.6 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.5 Related Work and Documents

.1 Section 01650 – Equipment Installation.

.2 Section 01664 – Training.

.3 Section 01670 - Commissioning.

.4 Division 16.

.5 Division 17.

2. PRODUCTS

2.1 General

.1 The boiler shall be designed for an operating pressure of 413 kPag (60 psig) and rated for 620 kPag (90 psig).

.2 Power: 600 V, 3 phase, 60 Hz.

2.2 Controls

.1 The boiler shall be fully equipped with all electrical and mechanical controls so that it is complete and ready to operate.

.2 Standard mechanical components provided shall include in a temperature controller, high temperature controller complete with manual reset, drain valve and pressure relief valve.

.3 Standard electrical components provided shall include a control circuit ON/OFF switch, fused control transformer, fused magnetic contactors derated to 90% of their rated capacity, electronic low water controller, pilots for “Power ON”, “Heat ON”, Low Water” and “High Temperature” and connection lugs for incoming power supply. Provide additional dry contacts for connection into the distributed control system (DCS) system as required.

2.3 Flanged Heaters

.1 The boiler shall be equipped with flanged immersion heaters.

.2 The flange heaters shall be incoloy sheathed and of low watt density.

2.4 Enclosure

.1 The boiler shall be enclosed in a sheet metal casing complete with wall mounting brackets.

3. EXECUTION

3.1 Installation

.1 Install in accordance with Manufacturer's instructions.

3.2 Equipment Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

FANCOIL UNITS

1. GENERAL

1.1 Scope

.1 Supply and install two (2) fan coil units complete with fan, coils and filters as indicated. One (1) serving the control room and one (1) serving the corridor and washroom.

1.2 Quality Assurance

.1 Thoroughly check system and make necessary corrections if system continually loses solution.

.2 Perform tests determining strength of glycol solution before system is turned over to the City. Provide test prior to end of guarantee and replenish as required. Provide written test results for review.

1.3 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electronic characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.

.7 Provide details showing condensate drain connection height and required P-trap height.

.8 Provide filter information, including initial air pressure drop (APD), final APD, dust spot efficiency, filter dust holding capacity, filter media description, filter frame details, filter replacement details and filter gauge details if applicable.

1.4 Related Work and Documents

.1 Section 01650 – Equipment Installation.

.2 Section 01664 – Training.

.3 Section 01670 - Commissioning.

.4 Division 16.

.5 Division 17.

2. PRODUCTS

2.1 General

.1 Basic unit shall consist of a base casing and return air plenum fabricated of heavy gauge galvanized steel with four-sided 25 mm (1 inch) duct collar for an easy connection to discharge ductwork. Return air plenum shall have filter frame with 20 mm (3/4 inch) return air duct collar. Plenum shall be fully insulated with foil faced, thermal and acoustic insulation to prevent glass fibres in the air stream, unit sweating and to attenuate fan noise.

.2 Standard of acceptance: McQuay model THC.

2.2 Fan Assembly

.1 Unit fan(s) shall be dynamically balanced, forward curved, double width, double inlet scroll centrifugal type constructed of galvanized steel for corrosion resistance. Motors shall be 115V/1Ø/60Hz three-speed, permanently lubricated sleeve bearing, permanent split capacitor with UL listed automatic reset thermal overload.

2.3 Coils

.1 Coils shall be aluminium fins with copper tubes mechanically expanded for a permanent bond. Coils shall have a brass header with 20mm (3/4 inch FPT) connections. Two (2) 20 mm x 15 mm (3/4 inch MPT x 1/2 inch) copper male adapters shall be provided by the Manufacturer for sweat connection to copper pipe.

Coils are tested at 2.93 MPag (425 psig) for one minute and 1.55 MPag (225 psig) for five minutes. Water coils to be provided with a hand operated, manual air vent requiring no tools for the venting operation.

2.4 Drain Pan

.1 Provide a removable, cleanable drain pan constructed of epoxy coated heavy gauge galvanized steel and externally insulated with 3mm (1/8 inch) closed cell insulation.

2.5 Filters

.1 Filters shall be nominal 25 mm (1 inch) throwaway type.

2.6 Electrical

.1 Unit shall be furnished with a single point power location, terminal strip and junction box for motor and other electrical terminals.

3. EXECUTION

3.1 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

COILS

1. GENERAL

1.1 Scope

.1 Glycol coils.

.2 Coil installation.

.3 Coil piping and accessories.

1.2 Quality Assurance

.1 Coils shall be the Product of Manufacturer regularly engaged in production of coils who issues complete catalogue data on such Products.

.2 Coil capacities, pressure drops, and selection procedures shall be certified in accordance with Air Conditioning and Refrigeration Institute (ARI) Standards and bear ARI seal.

1.3 Submittals

.1 Shop Drawings shall include dimensions, materials of construction and performance data to match Specifications.

.2 Submit coil selection sheets or computer calculations with Shop Drawings.

2. PRODUCTS

2.1 Glycol Heating Coils

.1 Primary Surface shall be round seamless 15 mm (1/2 inch) O.D. copper tube staged in the direction of the airflow. Tubes shall be on 40 mm (1-1/2 inch) or 75 mm (3 inch) centres.

.2 Secondary surface shall consist of rippled aluminium plate fins. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube. Bare copper tube shall not be visible between fins. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length.

.3 Casings shall be constructed of continuous galvanized steel with 10 mm (3/8 inch) bolt holes for mounting on 150 mm (6 inch) centres. Coil side plates shall be reinforced flange type.

.4 Coils shall have the connections located to permit unique mounting of the coil and have equal pressure drop through all circuits. Coils shall be circuited to provide the maximum mean effective temperature difference for maximum heat transfer rates. All coils over 1,125 mm (45 inch) fin length shall be furnished with four (4) fin angles to properly position the coil core.

.5 Headers shall be seamless copper tubing. The headers shall have intruded tube holes to provide large brazing surface for maximum strength and inherent flexibility. The complete coil shall be tested with 2.17 MPag (315 psig) air under water and be suitable for operation at 1.72 MPag (250 psig) and 150°C (300°F). Individual tube test and core tests before installation of the headers in not considered satisfactory. Hydronic tests alone shall not be acceptable.

3. EXECUTION

3.1 Installation

.1 Support coil sections on steel channel or double angle frames and secure to casings. Arrange galvanized steel casings for bolting to other section, ductwork or unit casings. Provide airtight seal between coils and duct or unit cabinets.

.2 Make necessary connections to coils, including valves, air vents, unions and connections from drip pans.

.3 Locate water supply at bottom of supply header and return water connection at top to provide self-venting and reverse return arrangement. Provide manual air vents at high points complete with stop valves. Ensure water coils are drainable and provide drain connection at low points.

.4 Protect coils so fins and flanges are not damaged. Replace loose and damaged fins. Comb out bent fins unless required to be replaced.

3.2 Performance

.1 Refer to Equipment Schedules.

END OF SECTION

HYDRONIC HEAT PUMPS

1. GENERAL

1.1 Scope

.1 The supply and installation of eight (8) hydronic heat pumps, including stands, starters and ancillaries.

1.2 Quality Assurance

.1 All units shall be Air Conditioning and Refrigeration Institute (ARI) certified, per Standard 320.

.2 Units shall be Underwriters Laboratories of Canada (ULC) and Canadian Standards Association (CSA) listed.

.3 Each unit shall be fully run tested at the factory, prior to shipment.

.4 Unit shall be supplied by a Manufacturer who maintains a local service agency and parts stock.

.5 Provide all motors with thermal overload protection.

.6 Units shall meet or exceed the indicated heating and cooling capacities. The indicated E.E.R. and C.O.P. shall be considered minimum.

1.3 Submittals

.1 Submit Shop Drawings which shall include the following minimum information:

.1 Construction material Specifications and construction details.

.2 Performance data in the form of tables, and unit selection points clearly indicated. Include E.E.R. and C.O.P. at the selected point.

.3 Electrical and controls wiring diagrams.

.4 Electrical motor data.

.5 Physical dimensions.

.6 Coil flows and pressure drops based on 30/70 ethylene glycol to water solution.

.7 Installation instructions.

.8 Operating and maintenance instructions.

1.4 Related Work and Documents

.1 Division 1.

.2 Division 16.

.3 Division 17.

2. PRODUCTS

2.1 Casing and Cabinet

.1 The cabinet shall be fabricated from heavy gauge stainless steel with removable access doors on all four sides and a hinged access door over the electrical cabinet.

.2 Insulate interior side of cabinet with 15 mm thick, 24 kg/m³ density, coated glass fibre with edges sealed or protected by flanges in the cabinet.

.3 The units shall have separate knockouts for the entrance of the low and high voltage wiring.

2.2 Refrigeration Circuit

.1 All units shall contain a sealed refrigerant circuit including a hermetic motor-compressor, thermal expansion valve, two (2) stainless steel brazed plate type heat exchanges, factory installed high and low pressure lockout switches and service ports and a liquid line filter-drier.

.2 Low-pressure lockout switch shall be electrical reset with interruption to power supply. High-pressure lockout shall be manual reset. High and low-pressure lockout switches shall be field adjustable.

.3 The compressor shall be:

.1 Designed for refrigeration duty, with internal isolation and mounted on rubber vibration isolators.

.2 Manufactured with oil-sight glass.

.3 Designed for use with R404-A or other non-HCFC refrigerant.

.4 Installed with Rotoloc fittings to facilitate service.

.4 The compressor motor shall have internal motor protection and shall be three-phase PSC type.

.5 The compressor shall be isolated from refrigerant circuit with flexible connections to minimize transfer of vibration to refrigerant tubing.

.6 The liquid to refrigerant heat exchangers shall be brazed plate type constructed with type 316 stainless steel and brazed with copper. The heat exchangers shall be designed for operation from -185°C to 230°C (-300°F to 450°F), and capable of withstanding 3.1 MPag (450 psig) working pressure on liquid and refrigerant sides. Heat exchangers shall be manufactured with built in refrigerant distributor tube with calibrated orifices to distribute gas evenly throughout the heat exchanger and be designed for use with R404-A or other acceptable non-HCFC refrigerant.

.7 The refrigerant circuit shall include a refrigerant solenoid valve to prevent liquid refrigerant migration to the evaporator.

.8 The thermal expansion valve shall provide proper superheat over liquid temperature range with minimal hunting.

.9 All refrigerant piping on suction side of compressor shall be insulated with 13mm closed-cell foam insulation to prevent condensation. Evaporator and condenser shall be insulated 13 mm closed cell insulation to prevent condensation. Refrigerant piping shall be clamped and supported to minimize vibration and stress cracking.

.10 Each unit shall be factory run-tested for a minimum of two hours under actual conditions. A copy of run test shall include:

.1 Amperage and voltage draw,

.2 Refrigerant pressures,

.3 Sight glass status,

.4 Operation and verification of high & low pressure controls,

.5 Entering and leaving fluid temperatures (30% ethylene glycol) for condenser and evaporator,

.6 Entering and leaving fluid pressures (30% ethylene glycol) for condenser and evaporator,

.7 Superheat measurement,

.8 Operation of compressor overload protection.

.11 A copy of the run-test shall be included in the installation manual shipped with the unit and copy shall be maintained at the factory.

.12 The fluid to fluid heat pumps shall be designed to operate with fluid source temperatures between 0°F (-17°C) and 110°F (43.3°C).

2.3 Electrical

.1 Controls and safety devices shall be factory wired and mounted within the unit. Controls shall include compressor contactor, 24 VAC 100 VA transformer with built-in circuit breaker, reset relay and anti-short cycle relay. A terminal block with screw terminals shall be provide a lockout circuit that requires resetting of low voltage supply or main circuit breaker.

.2 Electrical circuit shall include red fault light indicator light and green running indicator light on outside of cabinet, and shall include an "hand-on-auto" selector switch on the outside of the cabinet.

.3 Provide necessary dry contacts for connection into Distributed Control System (DCS) control system.

2.4 Piping

.1 All supply and return liquid connections shall be MPT flush mounted copper threaded fittings.

.2 Pressure and temperature ports shall be included on both condenser and evaporator fluid inlets and outlets.

2.5 Mounting Rack

.1 Units shall be mounted on welded aluminium rack supplied by the heat pump Manufacturer. The mounting rack shall include space for the mounting of two (2) circulating pumps per heat pump unit mounted on the rack.

2.6 Warranty

.1 All parts to be warranted to be free from defects for one year including a labour allowance ($300 minimum) from date of substantial completion.

.2 All compressors and refrigeration circuits shall be warranted to be free from defects for five years including labour allowance ($500 minimum) from date of substantial completion.

3. EXECUTION

3.1 Installation

.1 Install in accordance with Manufacturers recommendations.

3.2 Heat Pump Schedule

.1 Refer to 15999 – Equipment Schedules.

END OF SECTION

INDOOR PREMANUFACTURED AIR HANDLING UNITS

1. GENERAL

1.1 Scope

.1 Supply and install one semi-custom indoor air handling unit as indicated on Drawings. U-420-AHU-1 is hung from the structure in the UV Process room and serves the UV Process room. This unit provides ventilation, heating, cooling and dehumidification to the UV Process room. This unit has a return fan section (U-421-RF-1), economizer section, filter section (U-420-FS-1), glycol heating coil section (U-420-HC), glycol cooling coil section (U-420-CC), supply fan section (U-424-SF) and access sections as indicated.

1.2 References

.1 Anti-Friction Bearings Manufacturers Association (AFBMA) 9, Load Ratings and Fatigue Life for Ball Bearings

.2 Air Movement and Control Association (AMCA) 99, Standards Handbook

.3 AMCA 210, Laboratory Methods of Testing Fans for Rating Purposes

.4 AMCA 300, Test Code for Sound Rating Air Moving Devices

.5 AMCA 500, Test Methods for Louvers, Dampers and Shutters

.6 Air Conditioning and Refrigeration Institute (ARI) 410, Forced-Circulation Air-Cooling and Air-Heating Coils

.7 National Electrical Code (NEC)

.8 National Electrical Manufacturers Association (NEMA) MG1, Motors and Generators

.9 National Fire Protection Association (NFPA) 70, National Fire Protection Code

.10 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), Heating, Ventilation, and Air Conditioning (HVAC) Duct Construction Standards – Metal and Flexible

.11 Underwriters Laboratories of Canada (ULC) 900, Test Performance of Air Filter Units

.12 American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 62-2001, Ventilation for Acceptable Indoor Air Quality

1.3 Quality Assurance

.1 Local service shall be available either directly from the factory or through the local certified factory representatives.

.2 Major components shall be Products of recognized Manufacturers regularly engaged in production of such equipment and whose Products are in compliance with industry standards.

.3 The following parameters shall establish the selection criteria and shall be as specified: airflow rates, external static pressures, and water flow rates. The following are to be as specified or improved: coil and filter face velocities, cabinet air leakage rate, inlet/discharge/radiated sound power levels, and internal static pressure/brake horsepower.

.4 Unit casing leak rate shall not exceed 0.5 cfm per square foot of cabinet area at 5" static pressure in order to meet efficiency and indoor air quality standards.

.5 Units shall be factory built and shipped in a single piece, multiple sections or as a knock-down package depending on the project Specification and/or field restrictions.

.6 Fans shall conform to AMCA standards regarding testing and construction. Fans shall bear the AMCA certified rating seal for sound and airflow.

.7 Heating and cooling coils shall be ARI certified.

.8 Filter media shall be ULC listed.

.9 Units with factory wiring shall be Canadian Standards Association (CSA) or ETL approved for electrical safety.

.10 Provide all motors with thermal overload protection. Provide thermisters in motor windings. General motor data shall be in accordance with Section 15010 – Mechanical General Requirements.

.11 Start-up of unit shall be executed by Manufacturer's personnel.

.12 All components, paints and lining shall have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50.

1.4 Operation and Maintenance (O&M) Data

.1 Include instructions for lubrication, filter replacement, motor and drive adjustment and replacement, spare parts lists and wiring diagrams.

1.5 Delivery, Storage and Handling

.1 Accept Products on-site in factory applied protective wrapping, and factory installed lifting lugs. Inspect for damage. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.6 Environmental Requirements

.1 Do not operate units for any purpose, temporary or permanent, until Vendor installation certification has been completed, ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.

1.7 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electronic characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.

.7 Provide details showing condensate drain connection height and required P-trap height.

.8 Provide filter information, including initial air pressure drop (APD), final APD, dust spot efficiency, filter dust holding capacity, filter media description, filter frame details, filter replacement details and filter gauge details if applicable.

.9 Provide damper Shop Drawings indicating materials of construction, leak ratings, air pressure drops.

.10 Submit air handling unit inlet, discharge and radiated sound power levels at nominal capacity.

.11 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

.12 Submit Manufacturer's recommended installation instructions.

.13 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.8 Related Work and Documents

.1 Division 1

.2 Division 16.

.3 Division 17.

2. PRODUCTS

2.1 Components

.1 Air handling unit U-420-AHU-1 shall consist of, but not be limited to, the following components sections:

.1 Supply fan,

.2 Glycol cooling coil,

.3 Access,

.4 Glycol heating coil,

.5 Filter,

.6 Economizer and

.7 Return fan.

2.2 Casing

.1 **Post and Panel Construction including**:

Walls and ceilings shall be constructed with acoustic panels. The panels shall have a 50 mm (2 inch) cross section that includes a 50 mm (2 inch) thick fibreglass blanket.

The panel's exterior skin shall be 18 gauge G90 galvanized steel and the interior skin shall be 20 gauge G90 galvanized liner to permit washdown of the interior surface. The insulation shall have long resilient inorganic glass fibres bonded with a thermo-setting resin. The media shall have a density of 48 kg/m^3 (3.0 lb/ft^3) and be compressed by a minimum of 10%. The average thermal conductance of the panels shall not exceed 0.12 BTU/ft^2/hr/°F.

The channel posts shall be fabricated from 16 gauge G90 galvanized steel.

The panels and channel posts shall be assembled with screws and gasketed to ensure air tightness.

Sections shall be assembled bulb type gaskets and bolts.

The acoustic performance shall be in accordance with the following:

Octave Band	125	250	500	1000	2000	4000
Absorption Coefficient	0.33	0.72	1.11	1.05	1.10	1.01
Transmission Loss (dB)	20	23	35	46	54	59

.2 Base:

Construct from heavy gauge galvanized steel structural frame. The perimeter shall consist of a double galvanized steel formed channel. Intermediate channels and structural supports shall be heavy gauge galvanized steel. The base shall be of continuous construction and adjacent perimeter sections shall be joined by heavy-duty bolted assemblies. The structural perimeter shall include removable lifting lugs. The minimum base height shall be 100mm (4 inches).

.3 Floor:

Construct the floor from 20 gauge G90 galvanized steel. A 50 mm (2 inch) thick rigid fibreglass insulation shall be installed within the floor and protected from underneath by a galvanized steel liner.

2.3 Access Doors

.1 Access doors shall be manufactured from 18 gauge G90 galvanized steel. The doors shall be double wall construction with 18 gauge solid metal liner on the inside. 50 mm (2 inches) of insulation with a density of 48 kg/m^3 (3 lbs/ft^3) shall be sandwiched between the inner and outer layer.

.2 Door frames shall be made of 16 gauge G90 galvanized steel with the outside of the door flush with the unit. Doors to be sealed with automotive type 50 mm (1/2 inch) closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. (Neoprene or foam gaskets are not acceptable).

.3 Provide minimum two (2) ventlock latches per door openable from both sides. **Camlock latches are not acceptable**. Door hinge to be continuous cadmium plated piano hinge with brass pin.

.4 Provide access doors for the following Sections.

- Fan Sections

- Filter Section
- Economizer Section
- Access Sections

2.4 Marine Lights

.1 Provide marine type lights on all units with sections having an access door. Lights shall be factory installed and wired to a single lighted switch located outside the supply fan access door.

2.5 Drain Pans

.1 On units without stacked coils, provide a single fabricated 16 gauge stainless steel drain pan under cooling coils. On units with stacked coils, provide a separate drain pan under each coil. On all units, provide a secondary drain pan extending under the entire access section downstream of the cooling coil and humidifier section. Provide a drain pan to drain the fresh air intake or mixing plenum. Pipe all drains to the exterior side of unit.

2.6 Fan Sections

.1 Fans shall be either backward inclined, airfoil or forward curved as indicated in the schedules or as implied by the specified equipment.

.2 Fans performance shall be based on tests conducted in accordance with AMCA standard test code for air moving devices. All fans shall be certified to bear the AMCA certified rating seal. The fans shall have quiet and stable operation under all conditions. The fan Manufacturer shall provide sound power ratings in the eight octave bands which shall be based on AMCA standards. Sound power ratings shall be in decibels referenced to 10^{-12} watts.

.3 Fans shall be dynamically balanced. An IRD or PMC analyser shall be used to measure velocity, and the final reading shall not exceed 2.5 mm/s (0.1 in/s). The vibration level shall be recorded on the fans as proof of the final dynamic balance at the factory.

.4 Fans and motors shall be mounted on all welded steel integral base with 50 mm (2 inch) deflection spring isolators and supplied with flexible connection between the fan and the cabinet. Spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing. Less efficient 1 inch deflection isolators and rubber-in-shear isolators are not acceptable.

.5 Plenum fans shall be centred within the cabinet for best aerodynamics and the wheel tips shall be at least half a wheel diameter away from the cabinet to minimize air induced vibrations and enhanced airflow profiles.

.6 Housed centrifugal fans shall be double width and double inlet arrangement type 3. Air inlets shall be at least 0.7 of a wheel diameter away from the cabinet wall to minimize airflow resistance. Fans shall be centred within the cabinet for best aerodynamics.

.7 Wheel diameters and discharge areas shall be in accordance with the standard sizes adopted by AMCA. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration and pulsation. Housings shall be constructed of heavy-gauge steel and shall be continuously welded throughout. The standard coating shall be durable and heat resistant up to 260°C (500°F). Fan shafts shall be solid and keyed to fan wheels. They shall also be keyed to the sheaves for positive wheel and shaft interlock.

.8 The first critical shaft speeds shall be at least 125% (Class I and II) and 142% (Class III) of the fan's maximum operating speed.

.9 Bearings shall be designed for heavy-duty service with a minimum L-50 life of 200,000 hours. Bearing ratings are to be based on the fans' maximum catalogued operating speed and horsepower. Pillow block bearings shall be either single row ball or double row spherical roller type. Bearing bars shall be rigidly fixed to the base (bearing supports mounted to the inlet funnel are unacceptable). Bearing supports shall consist of two or more full-length structural uprights. Provide copper lubrication lines extended to the access side of unit. Grease fittings attached to fan base assembly near access door.

.10 Acceptable fan Manufacturers: Northern Blower, Chicago, Lau, Twin City, Barry Blower, Greenheck.

.11 Provide variable sheaves for motors 11.2 kW (15 hp) and under and fixed sheaves for motors 20hp and over.

2.7 Motors and Drives

.1 Motors shall be supplied in accordance with Section 15010 – Mechanical General Requirements and schedules. Motors shall be mounted on slide bases for proper alignment and belt tension adjustment.

.2 Provide v-belt, cast-iron sheaves, and reinforced rubber belts (minimum of two (2) belts per drive). The belts and drives shall be selected for minimum 150% of the motor nameplate horsepower. Provide adjustable motor sheaves on motors of 11.2 kW (15 hp) and less.

.3 Provide a metal belt guard having sides and face of galvanized steel with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes.

.4 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to the City.

2.8 Coils

.1 Coils shall be fully enclosed within the section and shall have double wall galvanized floor construction consistent with the unit casing construction.

.2 Piping connections shall extend to the outside through rubber grommets.

.3 Coils shall include galvanized steel blankout sheets to hold coils rigid and prevent air from bypassing the coils.

.4 Removable two inch thick access panels shall be provided on both sides to remove coils through casing wall. Coils shall be mounted on independent racks and shall be individually removable.

.5 Drains for drains pans shall be fully recessed in the drain pans to ensure complete drainage.

.6 Coils shall be tested in accordance with ARI standard 410.

.7 The complete coil core shall be tested with 2170 kPag (315 psig) of air pressure under warm water and be suitable for operation at 1725 kPag (250 psig) working pressure. Water coils shall be circuited for drainability without removing individual plugs from each tube.

.8 Limit cooling coil face velocity to 2.54 m/s (500 fpm).

.9 Limit heating coil face velocity to 3.0 m/s (600 fpm).

.10 Glycol coils:

.1 Fins have a minimum thickness of 0.20 mm (.0075 inches) with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes mechanically expanded into the fins to provide a continuous primary and secondary compression bond over the entire finned length for maximum heat transfer rates. Bared copper tube shall not be visible between fins.

.11 Water coils provided with headers of seamless copper tubing intruded tube holes to permit expansion and contraction without creating undue stress or strain. Carbon steel coil connections with connection size to be determined by Manufacturer based upon the most efficient coil circuiting or as indicated in schedules. Vent connections provided at the highest point to assure proper venting. Drain connections provided at the lowest point to insure complete drainage and freeze-up.

2.9 Filters

.1 Filter types, efficiencies and face areas shall be in accordance with the schedule.

.2 Filter section shall be front loading where access is available upstream of the filter section or slide out through the side when access is not available. Front loading filters shall be mounted on factory fabricated 16 gauge galvanized steel holding frames. Side access filters shall slide out through factory fabricated galvanized steel racks and shall have previously described access doors.

.3 Limit filter velocity based on face area to less than 2.54 m/s (500 fpm).

2.10 Filter Gauges

.1 Provide and flush mount Dwyer 2000 magnehelic air filter gauges.

.2 Static pressure tips, shut off valves and tubing shall be provided and installed by the AHU Manufacturer.

.3 One Magnehelic gauge shall be provided for each filter bank.

2.11 Economizer Section

.1 Economizer section shall be complete with parallel blade type dampers. They shall be positioned so that airstreams are directed into a merging pattern. Damper sizes shown are minimum allowable, in order to keep damper pressure drop and noise to a minimum. Furnish access doors to service linkages and actuators.

.2 The dampers shall be integral part of the Air Handling Units and shall be supplied and installed by the Air Handling Unit Manufacturer at the factory where indicated on the equipment schedule.

.3 Damper operators shall be supplied by controls Contractor and field installed by the controls Contractor.

.4 Electronic Damper Operators:

.1 Proportional actuator, spring return:

.1 Electronic direct coupled type which require no crankarm and linkage.

.2 Power supply: 24 VDC.

.3 Provide proportional damper control in response to 4 to 20 mA control input with the addition of a 500 Ω resistor.

.4 Designed so that may be used for either clockwise or counter-clockwise failsafe operation.

.5 Use a brushless DC motor and be protected from overload at all angles of rotation.

.6 Run time shall be constant and independent of torque.

.7 Two (2) SPDT, 6A, 250 VAC position switches, switching points fully adjustable over full actuator rotation.

.8 UL listed and CSA certified.

.9 Standard of acceptance: Belimo.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

.3 Standard of acceptance: Belimo.

.5 Aluminum Airfoil Dampers

.1 Thermally insulated dampers shall have the same general construction as above with the following features:

.2 Damper frame to be insulated with polystyrene on all sides. The hollow blades shall be filled with non-CFC, expanded polyurethane insulation for an insulation factor of R2.29 and a temperature index of 55. The entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.

.3 Air leakage through a 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 21 l/s per m^2 (4.12 cfm/ft^2) against a 1.0 kPa (4 in wg) differential static pressure at standard air, based on tests and procedures performed in accordance with AMCA Publication 511.

.4 Pressure drop through a fully opened 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 7.5 Pa (0.03 in wg) at 5 m/s (1000 fpm).

.5 Standard of acceptance: Tamco 9000 series.

2.12 Electricity, Power Package and Controls

.1 Wire power connection for all lights to one point for connection by Division 16.

.2 Light to be fed from a separate source so that the lights are operative even when the unit is off.

.3 Motors shall be wired to individual disconnects located outside their respective fan sections.

.4 All components shall be CSA and UL approved.

.5 Units shall be CSA or ETL factory approved for electrical safety. Approval includes a dielectric factory test. Approved air handling units shall a CSA or ETL label.

.6 Variable frequency drives are to be provided for motors as indicated. Refer to Specification section 16815 – Variable Frequency Drives.

3. EXECUTION

3.1 Installation

.1 Use all factory provided lifting lugs to rig the units or modules. Ensure that spreader bars are used to prevent damaging the cabinets.

.2 Lift modules in an upright position.

.3 Ensure housekeeping pads or mounting bases are level and in accordance with approved dimensions. Air handling units or modules shall be level, shim if necessary.

.4 Mechanical Contractor shall provide and install adequately sized P-traps for all condensate pipe connections. Disposal of condensate (cooling coil, steam or floor drains) shall be in accordance with local codes.

.5 Remove gussets, hold-down bolts and shipping fasteners.

.6 Assemble modules together according to the installation manual.

3.2 Pre-Operation Start-Up

.1 Remove fans' shipping restraints and level spring isolators. Adjust thrust restraints.

.2 Belt drives shall be adjusted for tension and alignment.

.3 Lubricate all bearings.

.4 Check fan motors for rotation and amp draw for each phase. Record information on the start-up data sheets.

3.3 Air Handling Unit Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

CUSTOM INDOOR PREMANUFACTURED AIR HANDLING UNITS

1. GENERAL

1.1 Scope

.1 Supply and install one (1) **custom manufactured** indoor air handling unit as indicated on Drawings. U-410-AHU-1 is located in the mechanical mezzanine and serves the Electrical room and Mechanical mezzanine. This unit provides ventilation, heating, cooling to the Electrical room and Mechanical mezzanine. This unit has a return fan section (U-411-RF and U-412-RF), economizer section, filter section (U-416-FS and U-417-FS), glycol cooling coil section (U-416-CC/U-417-CC), supply fan section (U-416-SF/U-417-SF) and access sections as indicated.

1.2 References

.1 Anti-Friction Bearings Manufacturers Association (AFBMA) 9, Load Ratings and Fatigue Life for Ball Bearings

.2 Air Movement and Control Association (AMCA) 99, Standards Handbook

.3 AMCA 210, Laboratory Methods of Testing Fans for Rating Purposes

.4 AMCA 300, Test Code for Sound Rating Air Moving Devices

.5 AMCA 500, Test Methods for Louvers, Dampers and Shutters

.6 Air Conditioning and Refrigeration Institute (ARI) 410, Forced-Circulation Air-Cooling and Air-Heating Coils

.7 National Electrical Code (NEC)

.8 National Electrical Manufacturers Association (NEMA) MG1, Motors and Generators

.9 National Fire Protection Association (NFPA) 70, National Fire Protection Code

.10 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), Heating, Ventilation, and Air Conditioning (HVAC) Duct Construction Standards – Metal and Flexible

.11 Underwriters Laboratories Inc. (UL) 900, Test Performance of Air Filter Units

.12 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62-2001, Ventilation for Acceptable Indoor Air Quality

1.3 Quality Assurance

.1 Local service shall be available either directly from the factory or through the local certified factory representatives.

.2 Major components shall be Products of recognized Manufacturers regularly engaged in production of such equipment and whose Products are in compliance with industry standards.

.3 The following parameters shall establish the selection criteria and shall be as specified: airflow rates, external static pressures, and water flow rates. The following are to be as specified or improved: coil and filter face velocities, cabinet air leakage rate, inlet/discharge/radiated sound power levels, and internal static pressure/brake horsepower.

.4 Unit manufacture shall provide tests to verify casing leakage. Casing leakage tests shall verify that unit casing leakage is less than 1% of design airflow at 1.5 times the design static pressure or 1.1 times the fans peak static pressure at design RPMs. Duct openings in positive pressure section shall be sealed. This section shall be connected to a fan developing 1.5 times design positive static pressure and CFM of this fan shall be read using a calibrated oriface plate device. CFM shall be considered casing leakage. Duct openings in negative pressure section shall be sealed. This section shall be connected to a fan developing 1.5 times design negative static pressure and CFM of this fan shall be read using a calibrated orifice device. CFM shall be considered casing leakage. Casing leakage must be less than 1% or unit design airflow. All tests shall be witnessed by the City's Representative and a formal written report including test results shall be submitted to Contract Administrator.

.5 Units shall be factory built and shipped in a single piece, multiple sections or as a knock-down package depending on the project Specification and/or field restrictions.

.6 Fans shall conform to AMCA standards regarding testing and construction. Fans shall bear the AMCA certified rating seal for sound and airflow.

.7 Heating and cooling coils shall be ARI certified.

.8 Filter media shall be ULC listed.

.9 Units with factory wiring shall be Canadian Standards Association (CSA) or ETL approved for electrical safety.

.10 Provide all motors with thermal overload protection. Provide thermisters in motor windings. General motor data shall be in accordance with Section 15010 – Mechanical General Requirements.

.11 Start-up of unit shall be executed by Manufacturer's personnel.

.12 All components, paints and lining shall have a flame spread rating of not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50.

1.4 Operation and Maintenance (O&M) Data

.1 Include instructions for lubrication, filter replacement, motor and drive adjustment and replacement, spare parts lists and wiring diagrams.

1.5 Delivery, Storage and Handling

.1 Accept Products on-site in factory applied protective wrapping, and factory installed lifting lugs. Inspect for damage. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish.

1.6 Environmental Requirements

.1 Do not operate units for any purpose, temporary or permanent, until Vendor installation certification has been completed, ductwork is clean, filters are in place, bearings lubricated and fan has been test run under observation.

1.7 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electronic characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation, gauges and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Provide coil selection data sheets, clearly showing input data with proper consideration for altitude, air density, glycol correction, as well as clearly indicating the selected coils' output data.

.7 Provide details showing condensate drain connection height and required P-trap height.

.8 Provide filter information, including initial air pressure drop (APD), final APD, dust spot efficiency, filter dust holding capacity, filter media description, filter frame details, filter replacement details and filter gauge details if applicable.

.9 Provide damper Shop Drawings indicating materials of construction, leak ratings, air pressure drops.

.10 Submit air handling unit inlet, discharge and radiated sound power levels at nominal capacity.

.11 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

.12 Submit Manufacturer's recommended installation instructions.

.13 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.8 Related Work and Documents

.1 Section 01650 – Equipment Installation.

.2 Section 01664 – Training.

.3 Section 01670 - Commissioning.

.4 Division 16.

.5 Division 17.

2. PRODUCTS

2.1 Components

.1 Air handling unit U-410-AHU-1 shall consist of, but not be limited to, the following components sections:

.1 Two (2) Supply Fan Sections. Supply fan and redundant supply fan with motorized isolation dampers,

.2 Two (2) Glycol Cooling Coil Sections. **Split** Glycol cooling coils and Split redundant glycol cooling coil,

.3 Access,

.4 Two (2) Filter Sections. Filter and redundant filter with motorized isolation dampers,

.5 Economizer (Waste Heat Damper, Exhaust Air Damper and Outside Air Damper) and

.6 Two (2) Return Fan Sections. Return fan and redundant return fan with motorized isolation dampers.

2.2 Casing

Walls and roofs shall be constructed of 16 gauge galvanized steel 100 mm (4 inch) thick acoustic thermal panels. The inner liner shall be 22 gauge solid wash down galvanized steel. Insulation shall be 50 mm (2 in) thick, 48 kg/m^3 (3 lb/ft^3) density fibreglass insulation. All permanently joined flanged panel surfaces shall be sealed with an individual strip of 3 mm x 10 mm (1/8 inch x 3/8 inch) tape sealer. Wall and roof seams shall be turned inward to provide a clean flush exterior finish. All panel seams shall be sealed during assembly to produce an airtight unit. The acoustic performance shall be in accordance with the following:

Test methods and facilities used to establish sound transmission loss values shall conform explicitly with the ASTM designation E90-85 and E413-73 as indicated below.

Sound Transmission Loss DB (ASTM E-90 & E413-73)

Wall Thickness	1	2	3	4	5	6	7	8	STC
50 mm (2 in)	18	19	27	33	43	52	52	52	37

Test methods and facilities used to establish sound absorption values shall conform explicitly with the requirements of the ASTM Standard Test Method for Sound Absorption Coefficients by the Reverberation Method: ASTM C423-84A and E795-83

The Manufacturer shall submit the lab report for approval.

.1 Base:

.1 Units shall be constructed from structural steel C-channel around the perimeter of the unit with intermediate channel and angle iron supports. Units less than or equal to 6 m (20 feet) in length shall have a minimum 100 mm (4 in) channel, and units greater than 6 m (20 feet) in length shall have a minimum 150 mm (6 in) channel.

.2 A 12 gauge checker plate floor shall be installed on the base. The floor shall be flat, reinforced from below, with all seams continuously welded. Drive screw attachment and caulking are not acceptable. The base shall be provided with lifting lugs, a minimum of four (4) per unit section. The base shall be insulated with 50 mm (2 in) fiberglass insulation and sheeted with a 22 gauge galvanized steel liner. Floors that "oil can" are not acceptable.

.3 The Manufacturer shall provide a 40 mm (1-1/2 in) perimeter collar around the entire unit and around each floor opening to ensure the unit is internally watertight. The entire base shall act as an auxiliary drain pan and hold up to 40 mm (1-1/2 in) of water.

2.3 Access Doors

.1 Access doors shall be manufactured from 16 gauge G90 galvanized steel. The doors shall be double wall construction with 22 gauge solid metal liner on the inside. Two inches of insulation with a density of 48 kg/m^3 (3 lb/ft^3) shall be sandwiched between the inner and outer layer.

.2 Door frames shall be made of 16 gauge G90 galvanized steel with the outside of the door flush with the unit. Doors to be sealed with automotive type 15 mm (1/2 in) closed cell hollow round black gasket with a metal encapsulated reinforced backing that mechanically fastens to the door frame. (Neoprene or foam gaskets are not acceptable).

.3 Provide minimum two (2) ventlock latches per door openable from both sides. **Camlock latches are not acceptable**. Door hinge to be continuous cadmium plated piano hinge with brass pin.

.4 Provide access doors for the following Sections.

- Fan Sections
- Filter Section
- Economizer Section
- Access Sections

2.4 Marine Lights

.1 Provide marine type lights in all Sections having an access door on all units. Lights shall be factory installed and wired to a single lighted switch located outside the supply fan access door.

2.5 Drain Pans

.1 On units without stacked coils, provide a single fabricated 16 gauge stainless steel drain pan under cooling coils. On units with stacked coils, provide a separate drain pan under each coil. On all units, provide a secondary drain pan extending under the entire access section downstream of the cooling coil and humidifier section. Provide a drain pan to drain the fresh air intake or mixing plenum. Pipe all drains to the exterior side of unit.

2.6 Fan Sections

.1 Fans shall be either backward inclined, airfoil or forward curved as indicated in the schedules or as implied by the specified equipment.

.2 Fans performance shall be based on tests conducted in accordance with AMCA standard test code for air moving devices. All fans shall be certified to bear the AMCA certified rating seal. The fans shall have quiet and stable operation under all conditions. The fan Manufacturer shall provide sound power ratings in the eight octave bands which shall be based on AMCA standards. Sound power ratings shall be in decibels referenced to 10^{-12} watts.

.3 Fans shall be dynamically balanced. An IRD or PMC analyser shall be used to measure velocity, and the final reading shall not exceed 2.5 mm per second (0.1 inch per second). The vibration level shall be recorded on the fans as proof of the final dynamic balance at the factory.

.4 Fans and motors shall be mounted on all welded steel integral base with 50 mm (2 in) deflection spring isolators and supplied with flexible connection between the fan and the cabinet. Spring thrust restraints shall be supplied for stable operation and to protect the flexible connections from tearing. Less efficient 25 mm (1 in) deflection isolators and rubber-in-shear isolators are not acceptable.

.5 Plenum fans shall be centred within the cabinet for best aerodynamics and the wheel tips shall be at least half a wheel diameter away from the cabinet to minimize air induced vibrations and enhanced airflow profiles.

.6 Housed centrifugal fans shall be double width and double inlet arrangement type 3. Air inlets shall be at least 0.7 of a wheel diameter away from the cabinet wall to minimize airflow resistance. Fans shall be centred within the cabinet for best aerodynamics.

.7 Wheel diameters and discharge areas shall be in accordance with the standard sizes adopted by AMCA. Inlets shall be fully streamlined and housings shall be suitably braced to prevent vibration and pulsation. Housings shall be constructed of heavy-gauge steel and shall be continuously welded throughout. The standard coating shall be durable and heat resistant up to 260°C (500°F). Fan shafts shall be solid and keyed to fan wheels. They shall also be keyed to the sheaves for positive wheel and shaft interlock.

.8 The first critical shaft speeds shall be at least 125% (Class I and II) and 142% (Class III) of the fan's maximum operating speed.

.9 Bearings shall be designed for heavy-duty service with a minimum L-50 life of 200,000 hours. Bearing ratings are to be based on the fans' maximum catalogued operating speed and horsepower. Pillow block bearings shall be either single row ball or double row spherical roller type. Bearing bars shall be rigidly fixed to the base (bearing supports mounted to the inlet funnel are unacceptable). Bearing supports shall consist of two or more full-length structural uprights. Provide copper lubrication lines extended to the access side of unit. Grease fittings attached to fan base assembly near access door.

.10 Acceptable fan Manufacturers: Northern Blower, Twin City, Barry Blower.

.11 Provide variable sheaves for motors 11.2 kW (15 hp) and under and fixed sheaves for motors 14.9 kW (20 hp) and over.

2.7 Motors and Drives

.1 Motors shall be supplied in accordance with Section 15010 – Mechanical General Requirements and schedules. Motors shall be mounted on slide bases for proper alignment and belt tension adjustment.

.2 Provide v-belt, cast-iron sheaves, and reinforced rubber belts (minimum of two (2) belts per drive). The belts and drives shall be selected for minimum 150% of the motor nameplate horsepower. Provide adjustable motor sheaves on motors of 11.2 kW (15 hp) and less.

.3 Provide a metal belt guard having sides and face of galvanized steel with openings for fan tachometer readings. Belt guard shall be sized to allow either sheave to be increased by two sizes.

.4 Provide and install pulleys and sheaves for rotating equipment, as required to properly balance the systems to design flows, without additional cost to City.

2.8 Coils

.1 Coils shall be fully enclosed within the section and shall have double wall galvanized floor construction consistent with the unit casing construction.

.2 Piping connections shall extend to the outside through rubber grommets.

.3 Coils shall include galvanized steel blankout sheets to hold coils rigid and prevent air from bypassing the coils.

.4 Removable 50 mm (2 inch) thick access panels shall be provided on both sides to remove coils through casing wall. Coils shall be mounted on independent racks and shall be individually removable.

.5 Drains for drains pans shall be fully recessed in the drain pans to ensure complete drainage.

.6 Capacities, pressure drops and selection procedure shall be certified in accordance with ARI Standard 410.

.7 The complete coil core shall be tested with 2.17 MPag (315 psig) of air pressure under warm water and be suitable for operation at 1.72 MPag (250 psig) working pressure. Water coils shall be circuited for drainability without removing individual plugs from each tube.

.8 Limit cooling coil face velocity to 2.54 m/s (500 fpm).

.9 Glycol coils:

.1 Fins have a minimum thickness of 0.20 mm (0.0075 inches) with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes mechanically expanded into the fins to provide a continuous primary and secondary compression bond over the entire finned length for maximum heat transfer rates. Bared copper tube shall not be visible between fins.

.10 Water coils provided with headers of seamless copper tubing intruded tube holes to permit expansion and contraction without creating undue stress or strain. Carbon steel coil connections with connection size to be determined by Manufacturer based upon the most efficient coil circuiting or as indicated in schedules. Vent connections provided at the highest point to assure proper venting. Drain connections provided at the lowest point to insure complete drainage and freeze-up.

2.9 Filters

.1 Filter types, efficiencies and face areas shall be in accordance with the schedule.

.2 Filter section shall be front loading where access is available upstream of the filter section or slide out through the side when access is not available. Front loading filters shall be mounted on factory fabricated 16 gauge galvanized steel holding frames. Side access filters shall slide out through factory fabricated galvanized steel racks and shall have previously described access doors.

.3 Limit filter velocity based on face area to less than 2.54 m/s (500 fpm).

2.10 Filter Gauges

.1 Provide and flush mount Dwyer 2000 magnehelic air filter gauges.

.2 Static pressure tips, shut off valves and tubing shall be provided and installed by the AHU Manufacturer.

.3 One Magnehelic gauge shall be provided for each filter bank.

2.11 Economizer Section

.1 Economizer section shall be complete with parallel blade type dampers. They shall be positioned so that airstreams are directed into a merging pattern. Damper sizes shown are minimum

allowable, in order to keep damper pressure drop and noise to a minimum. Furnish access doors to service linkages and actuators.

.2 The dampers shall be integral part of the Air Handling Units and shall be supplied and installed by the Air Handling Unit Manufacturer at the factory where indicated on the equipment schedule.

2.12 Electronic Damper Operators:

.1 Proportional actuator, spring return:

.1 Power supply: 24 VDC.

.2 Provide proportional damper control in response to 4 to 20 mA control input with the addition of a 500 Ω resistor.

.3 Designed so that may be used for either clockwise or counter-clockwise failsafe operation.

.4 Use a brushless DC motor and be protected from overload at all angles of rotation.

.5 Run time shall be constant and independent of torque.

.6 Two (2) SPDT, 6A, 250 VAC position switches, switching points fully adjustable over full actuator rotation.

.7 UL listed and CSA certified.

.2 On-Off actuators, non-spring return:

.1 Power supply 24 VDC +/- 10%

.2 Electronic direct coupled type which require no crankarm and linkage.

.3 UL listed and CSA certified.

.4 Reversing switch and manual override on cover.

.5 Use a brushless DC motor and be protected from overload at all angles of rotation.

.6 Run time shall be constant and independent of torque.

.3 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one damper operator per damper section.

.4 Standard of acceptance: Belimo.

2.13 Aluminum Airfoil Dampers

.1 Thermally insulated dampers shall have the same general construction as above with the following features:

.2 Damper frame to be insulated with polystyrene on all sides. The hollow blades shall be filled with non-CFC, expanded polyurethane insulation for an insulation factor of R2.29 and a temperature index of 55. The entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.

.3 Air leakage through a 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 21 l/s per m^2 (4.12 cfm/ft^2) against a 1.0 kPa (4 in wg) differential static pressure at standard air, based on tests and procedures performed in accordance with AMCA Publication 511.

.4 Pressure drop through a fully opened 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 7.5 Pa (0.03 in wg) at 5 m/s (1000 fpm).

.5 Standard of acceptance: Tamco 9000 series.

2.14 Electricity, Power Package and Controls

.1 Wire power connection for all lights to one point for connection by Division 16.

.2 Light to be fed from a separate source so that the lights are operative even when the unit is off.

.3 Motors shall be wired to individual disconnects located outside their respective fan sections.

.4 All components shall be CSA and UL approved.

.5 Units shall be CSA or ETL factory approved for electrical safety. Approval includes a dielectric factory test. Approved air handling units shall a CSA or ETL label.

.6 Variable frequency drives are to be provided for motors as indicated. Refer to Specification Section 16815 – Variable Frequency Drives.

3. EXECUTION

3.1 Installation

.1 Use all factory provided lifting lugs to rig the units or modules. Ensure that spreader bars are used to prevent damaging the cabinets.

.2 Lift modules in an upright position.

.3 Ensure housekeeping pads or mounting bases are level and in accordance with approved dimensions. Air handling units or modules shall be level, shim if necessary.

.4 Mechanical Contractor shall provide and install adequately sized P-traps for all condensate pipe connections. Disposal of condensate (cooling coil, steam or floor drains) shall be in accordance with local codes.

.5 Remove gussets, hold-down bolts and shipping fasteners.

.6 Assemble modules together according to the installation manual.

3.2 Pre-Operation Start-Up

.1 Remove fans' shipping restraints and level spring isolators. Adjust thrust restraints.

.2 Belt drives shall be adjusted for tension and alignment.

.3 Lubricate all bearings.

.4 Check fan motors for rotation and amp draw for each phase. Record information on the start-up data sheets.

3.3 Air Handling Unit Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

1. GENERAL

1.1 Scope

.1 Centrifugal Roof mounted fans.

.2 Bathroom exhaust fans.

1.2 Quality Assurance

.1 Conform to Air Movement and Control Association (AMCA) Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

.2 Fans shall bear Canadian Standards Association (CSA) label.

.3 Motors to be high efficiency as specified in Section 15010.

1.3 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Product data shall include dimensions, weights, capacities, component performances, electrical characteristics, construction details, required clearances, field connection details (indicating size and location), proposed test descriptions and sample reports, pressure drops, vibration isolation and finishes of materials.

.5 Provide fan performance curves depicting the operating point described on the schedule for each individual fan.

.6 Submit fan inlet, discharge and radiated sound power levels at nominal capacity.

.7 Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring; clearly indicating factory installed and field installed wiring and accessories.

.8 Submit Manufacturer’s recommended installation instructions.

.9 Omission of any of the above information will cause submittal package to be immediately returned without review.

1.4 Job Conditions

.1 Do not operate fans for any purpose, temporary or permanent until ductwork is clean, filters are in place, bearings are lubricated and fan has been run under close supervision of unit Manufacturer.

1.5 Alternates

.1 Equivalent fan selections shall not increase motor kilowatts, increase rpm, increase noise level, increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that of the specified fan.

1.6 Related Work and Documents

.1 Division 1

.2 Division 16.

.3 Division 17.

2. PRODUCTS

2.1 General

.1 Statically and dynamically balance fans so no objectionable vibration or noise is transmitted to occupied areas of the building.

.2 Fans are to be capable of accommodating static pressure variations of $\pm$10% with no objectionable operating characteristics.

.3 Fan suppliers to provide replacement sheaves for balancing purposes.

.4 Provide belt guards with tachometer holes.

.5 External static pressure means external to the fan cabinet and all accessories such as backdraft dampers, mixing boxes, filters and coils, etc. These accessories if supplied as part of the unit are considered as internal losses for fan.

.6 Variable speed applications: shall be inverter duty c/w variable speed drive matched to fan motor.

2.2 Centrifugal Roof Mounted Fans

.1 The housing shall be weatherproof, utilizing heavy gauge spun aluminium construction with a large rolled bead for strength, with galvanized base and rigid galvanized steel internal support structures. Housing shall not provide any internal structural support.

.2 Units shall be equipped with an oversized electrical conduit chase through the curb cap and into the motor compartment for ease of wiring. Unit shall be pre-wired to a junction box mounted in the motor compartment and equipped with an electrical disconnect device.

.3 Statically and dynamically balanced backward inclined, centrifugal wheels shall be aluminium, spark-resistant non-overloading and matched to deeply spun venturis.

.4 Motors shall be continuous duty, ball bearing design, permanently lubricated, mounted out of the main air stream and furnished at the specified voltage, phase and enclosure.

.5 Shafts shall be turned, ground, polished and rust protected.

.6 Heavy duty ball bearings are rated for a minimum L50 life exceeding 200,000 hours.

.7 Pulleys be adjustable, cast iron, machined, keyed, securely attached and sized for 150% of the horsepower at its rated maximum speed.

.8 Each fan shall bear the AMCA Listed Ratings Seal for Air and Sound Performance and shall be Underwriters Laboratories Inc. (UL) and CSA listed.

.9 Drip trays as noted.

2.3 Bathroom Exhaust Fans

.1 The fan housing shall be constructed of heavy gauge galvanized steel with a powder coated finish. Internal air turning vanes shall be provided for maximum air performance. Fan shall be supplied with externally mounted electrical terminal box with pre-wired terminal strip connections.

.2 Motorized impeller shall be an external rotor type, class B insulation, totally enclosed shaded pole type. Motor shall be permanently sealed self lubricating bearing type. Motor shall be equipped with automatic reset thermal overload protection. Motor shall be acceptable for continuous duty. Sufficient service factor shall be provided to ensure long maintenance free operation over maximum load conditions.

.3 Fan wheel shall be of the backward inclined airfoil type. Motorized impeller shall be both statically and dynamically balanced as one integral component.

.4 Each fan shall bear the AMCA Licensed Ratings Seal for Air and Sound Performance, and shall be UL and CSA listed.

3. EXECUTION

3.1 Installation

.1 Where inlet or outlet is exposed, provide safety screen.

.2 Provide belt guards on belt driven fans complete with tachometer access.

.3 Supply and install sheaves as necessary for final air balancing.

3.2 Performance

.1 Fan performance indicated in schedules are based on sea level conditions.

.2 Refer to Equipment Schedule.

END OF SECTION

DUCTWORK

1. GENERAL

1.1 Scope

.1 Ductwork and plenums.

.2 Fasteners.

.3 Sealants.

.4 Duct cleaning.

1.2 Definitions

.1 Low Pressure: Static pressure in duct less than 500 Pa (2 in wg) and velocities less than 10 m/s (2,000 fpm).

.2 Medium Pressure: Static pressure in duct less than 1,500 Pa (6 in wg) and velocities greater than 10 m/s (2,000 fpm).

.3 High Pressure: Static pressure over 1,500 Pa (6 in wg) and less than 2,500 Pa (10 in wg) and velocities greater than 10 m/s (2,000 fpm).

.4 Duct sizes shown on plans are inside clear dimensions. For acoustically lined or internally insulated ducts, maintain sizes inside ducts.

1.3 Quality Assurance

.1 Ductwork shall meet the requirements of National Fire Protection Association (NFPA) No. 90A - Air Conditioning and Ventilating Systems and NFPA No. 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

.2 Fabricate in accordance with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) duct manuals and American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) handbooks.

.3 Flexible air duct shall conform to NFPA 90A and Underwriters Laboratories Inc. (UL) 181 standard for factory made air duct materials and air duct connectors.

1.4 Submittals

.1 Submit Shop Drawings and samples of duct fittings for approval, including particulars such as gauge sizes, welds and configurations prior to start of Work.

1.5 Alternatives

.1 Obtain written permission from the Contract Administrator prior to making variations in duct configuration or sizes. Size alternatives using ASHRAE table for circular equivalents of rectangular ducts.

2. PRODUCTS

2.1 Materials

.1 Ducts: Galvanized steel lock forming quality, having galvanized coating of 380 g/m^2 (1.25 oz/ft^2) for both sides.

.2 Fasteners: Use rivets and bolts throughout; sheet metal screws accepted on low pressure ducts.

.3 Sealant: Water resistant, fire resistive, compatible with mating materials.

3. EXECUTION

3.1 Installation

.1 Fabricate ductwork from field measurements and not from plans and Shop Drawings exclusively. Failure to do so will not constitute an extra to the Contract.

.2 Complete metal ducts within themselves with no single partition between ducts. Where width of duct exceeds 450 mm (18 in) crossbrace for rigidity. Open corners are not acceptable.

.3 Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth duct interior.

.4 Construct tees, bends and elbows with radius of not less than 1.5 times width of cut on centre line. Where not possible and where rectangular elbows are specified, provide double wall air foil type turning vanes. Where acoustical lining is provided, provide turning vanes of perforated metal type with fibreglass inside.

.5 Increase duct sizes gradually, not exceeding 15° divergence wherever possible. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.

.6 Rigidly construct metal ducts with joints mechanically tight, substantially airtight, braced and stiffened so as not to breathe, rattle, vibrate or sag. Caulk duct joints and connections with sealant as ducts are being assembled. Seal seams on fresh air and exhaust ducts watertight with mastic or low velocity duct sealant.

.7 Provide drains in fresh air and humidifier sections with deep seal traps.

.8 Set plenum doors 150 mm (6 in) above floor. Arrange door swings so that fan static holds door in closed position.

3.2 Plenum Gauges

.1 Fabricate fan plenums and plenums downstream of fan in accordance with SMACNA manual.

.2 Fabricate plenums between fan and upstream apparatus of 1.6 mm (16 ga) thick material.

.3 Fabricate plenums between filters and upstream apparatus of 1.3 mm (18 ga) thick material.

3.3 Duct Sealing

.1 All supply, return and exhaust duct joints, longitudinal as well as transverse, should be sealed using:

.1 Low Pressure Ductwork:

- Slip Joints: Apply heavy brush-on high pressure duct sealant. Apply second application after the first application has completely dried out. Where metal clearance exceeds 1.5 mm (0.06 in) use heavy mastic type sealant.
- Flanged Joints: Soft elastomer butyl or extruded form of sealant between flanges followed by an application of heavy brush-on high pressure duct sealant.
- Other Joints: Heavy mastic type sealant.

.2 Medium and High Pressure Ductwork: Combination of woven fabrics and sealing compound followed by an application of high pressure duct sealant.

.2 Duct tapes as sealing method are not permitted.

.3 Surfaces to receive sealant should be free from oil, dust, dirt, moisture, rust and other substances that inhibit or prevent bonding.

.4 Prior to sealing all ductwork, demonstrate sealing of a section of each type of duct and obtain approval from the Contract Administrator.

.5 Do not insulate any section of the ductwork until it has been inspected and approved of duct sealant application.

3.4 Installation

.1 Locate ducts with sufficient space around equipment to allow normal operation and maintenance activities.

.2 Co-ordinate the location of duct access doors. Refer to Section 15835 - Duct Accessories.

.3 Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

.4 Interrupt duct linings at fire, balancing backdraft and smoke dampers so as not to interfere with operation of devices. Provide sheet metal edge protection over linings on both sides of damper device.

.5 Shield ductwork from dust and construction material during construction. Clean any ductwork found to be dirty at no extra cost to the Contract.

.6 Protect carbon steel ductwork exposed to weather by painting or coating with suitable weather resistant material.

.7 Install ducts associated with fans subject to forced vibration with flexible connections immediately adjacent to equipment. Refer to Section 15835 - Duct Accessories.

.8 Prove that ductwork is substantially air tight before covering or concealing.

.9 Clean duct systems and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning.

END OF SECTION

DUCT ACCESSORIES

1. GENERAL

1.1 Scope

.1 Access doors.

.2 Motorized dampers.

.3 Fire dampers.

.4 Balancing dampers.

.5 Flexible connections.

1.2 Quality Assurance

.1 Fire dampers shall be Underwriters Laboratories of Canada (ULC) listed and constructed in accordance with ULC Standard S 112 “Fire Dampers”.

.2 Fusible links on fire dampers shall be constructed to ULC Standard S 505.

.3 Demonstrate re-setting of fire dampers to authorities having jurisdiction and the City's Representative.

.4 Access doors shall be ULC labelled.

.5 Accessories shall meet the requirements of National Fire Protection Association (NFPA) 90A, Air Conditioning and Ventilating Systems. Fabricate in accordance with American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Handbooks and Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA) Duct Manuals.

.6 Prove all dampers to inspector at job completion.

1.3 Submittals

.1 Submit Shop Drawings of factory fabricated assemblies.

.2 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.3 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.4 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the

responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

2. PRODUCTS

2.1 Duct Access Doors

.1 Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and suitable quick fastening locking devices. Duct access panels with screws are not acceptable. Install minimum 25 mm (1 in.) thick insulation with suitable sheet metal cover frame for insulated ductwork.

.2 Fabricated with two (2) butt hinges and two (2) sash locks for sizes up to 450 mm (18 in.), two (2) hinges and two (2) compression latches with outside and inside handles for sizes up to 600 mm x 1200 mm (24 in. x 48 in.) and an additional hinge for larger sizes.

2.2 Motorized Dampers

.1 Thermally insulated dampers shall have the same general construction as above with the following features:

.2 Damper frame to be insulated with polystyrene on all sides. The hollow blades shall be filled with non-CFC, expanded polyurethane insulation for an insulation factor of R2.29 and a temperature index of 55. The entire frame shall be thermally broken by means of polyurethane resin pockets complete with thermal cuts.

.3 Air leakage through a 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 21 l/s per m^2 (4.12 cfm/ft^2) against a 1.0 kPa (4 in wg) differential static pressure at standard air, based on tests and procedures performed in accordance with AMCA Publication 511.

.4 Pressure drop through a fully opened 1.2 m by 1.2 m (48 inch by 48 inch) damper shall not exceed 7.5 Pa (0.03 in wg) at 5 m/s (1000 fpm).

.5 Standard of acceptance: Tamco 9000 series.

.6 Electronic Damper Operators:

.1 Proportional actuator, spring return:

.1 Electronic direct coupled type which require no crankarm and linkage.

.2 Power supply: 24 VDC.

.3 Provide proportional damper control in response to 4 to 20 mA control input with the addition of a 500 Ω resistor.

.4 Designed so that may be used for either clockwise or counter-clockwise failsafe operation.

.5 Use a brushless DC motor and be protected from overload at all angles of rotation.

.6 Run time shall be constant and independent of torque.

.7 Two (2) SPDT, 6A, 250 VAC position switches, switching points fully adjustable over full actuator rotation.

.8 UL listed and CSA certified.

.2 Provide sufficient damper motors to achieve unrestricted movement, with a minimum of one (1) damper operator per damper section.

.3 Standard of acceptance: Belimo.

2.3 Fire Dampers

.1 Fabricate of galvanized steel or prime coated black steel weighted to close and lock in closed position when released by fusible ink.

.2 Fire dampers shall be curtain type with damper blades retained out of air stream in a recess so free area of connecting ductwork is not reduced.

.3 Fusible links shall be set for 71° C (160° F).

2.4 Balancing Dampers

.1 Fabricate of galvanized steel, minimum 1.6 mm (16 ga). Full blade-length shafts of hollow square construction with blades rigidly fastened along entire blade length.

.2 Lockable quadrant type operating mechanism with end bearings on accessible rectangular ducts up to 400 mm (16 in.) deep and on accessible round ducts.

.3 Wide pitch screw operating mechanism with crank operator and end bearings on accessible rectangular ducts 425 mm (17 in) and over in depth and on all inaccessible rectangular and round ducts.

.4 On rectangular ducts up to 275 mm (11 in.) deep construct of single blade (butterfly) type.

.5 On rectangular ducts 300 mm to 400 mm (12 in. to 16 in.) deep construct of two (2) opposed blades mechanically interlocked with pivots at quarter points.

.6 On rectangular ducts over 425 mm (17 in.) deep construct of multiple opposed blades mechanically interlocked with blades no greater than 200 mm deep and pivots equally spaced.

.7 On round ducts construct of single blade (butterfly) type. On 500 Pa (2 in wg) class and on all dampers over 300 mm (12 in.) diameter fabricate with full blade-length shaft.

.8 Construct damper blades for medium and high pressure systems to block air passage 70% maximum. Provide complete with locking type handles.

.9 Provide over-ride limiting stops on all operating mechanisms.

.10 Identify the air flow direction and blade rotation and open and close positions on operating mechanism.

.11 On round ductwork install operating mechanism on a steel mounted base firmly secured to the ductwork.

.12 On externally insulated ductwork, install operating mechanisms on a steel bridge type mounting base to permit continuity of insulation under the mechanism.

2.5 Flexible Connections

.1 Fabricate of ULC approved neoprene coated flameproof glass fabric approximately 150 mm (6 in.) wide tightly crimped into metal edging strip and attached to ducting and equipment by screws or bolts at 150 mm (6 in.) intervals. Flexible connection airtight at 500 Pa (2 in wg).

.2 Do not use flexible connections to connect kitchen ductwork to kitchen fans where the fan is mounted inside the building enclosure. Fan connections in these cases shall be governed by NFPA 96 (flanged connections).

3. EXECUTION

3.1 Application

.1 Provide access door minimum 450 mm x 350 mm (18 in x 14 in.) or 50 mm (2 in.) smaller than duct dimension for cleaning and inspection at positions indicated by Drawings and as follows:

- Both sides of turning vanes in all ducts.
- At each fire damper location.
- At each side of all heating or cooling coils.
- At all locations of internally duct mounted devices including automatic dampers, damper motors and control sensors and devices.

.2 Provide fire dampers at locations shown, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Fire dampers shall be complete with required perimeter mounting angles sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

.3 At each point where ducts pass through fire separation duct shall be sealed with non-combustible material.

.4 Provide motorized dampers where indicated on Drawings c/w appropriately sized actuators.

.5 Provide balancing dampers at points on supply and exhaust systems where branches are taken from larger ducts as required for proper air balancing.

.6 Install ducts associated with fans and equipment subject to forced vibration with flexible connections, immediately adjacent to equipment and/or where indicated on Drawing.

.7 All fire dampers are to be left in the closed position for balancing Contractor to fix open.

END OF SECTION

AIR OUTLETS

1. GENERAL

1.1 Scope

.1 Diffusers.

.2 Grilles and registers.

.3 Outside louvers

.4 Gravity hoods.

1.2 Quality Assurance

.1 Air flow tests and sound level measurement shall be made in accordance with applicable ADC equipment test codes, American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards and Air Movement and Control Association (AMCA) Standards.

.2 Unit rating shall be approved by ADC and AMCA.

.3 Manufacturer shall certify catalogued performance and ensure correct application of air outlet types.

.4 Outside louvres shall bear AMCA seal for free area and water penetration.

1.3 Project Conditions

.1 Review requirements of outlets as to size, finish and type of mounting prior to submitting Shop Drawings and schedules of outlets.

.2 Positions indicated are approximate only. Check locations of outlets and make necessary adjustments in position to conform with Architectural features, symmetry and lighting arrangement.

1.4 Submittals

.1 Submit Shop Drawings and Product data in accordance with Section 01300 – Submittals and Section 15010 – Mechanical General Requirements.

.2 Shop Drawings shall be clear and legible, facsimiles will not be accepted. Provide a cover page for each air handling unit, showing the project name, consulting engineer, mechanical Contractor, tagging information, revision if applicable and submission date, leaving adequate space for approval stamps.

.3 Provide all technical information relevant to the Product being provided, including but not limited to all the information shown in the schedules of the Specification. It is the

responsibility of the vendor to highlight any variances the equipment has with the requirements of this Specification.

.4 Submit Shop Drawings with complete catalogue information, materials of construction, dimensions and accessories for all air outlets, louvres and components in this Specification Section, and as scheduled.

.5 Submit AMCA laboratory test report on a 1200 mm x 1200 mm (4 ft x 4 ft) unit demonstrating that it provides a minimum of 0.740 m^2 (7.96 ft^2) of free area and shall intake 192 m/min (629 fpm) free area velocity at a static pressure drop not exceeding 20 Pa (0.08 in wg) per square foot of free area at a velocity of 192 m/min (629 fpm) when tested for 15 minutes per AMCA Standard 500-L-99.

.6 Submit colour selection charts of finishes for approval prior to fabrication.

2. PRODUCTS

2.1 General

.1 Base air outlet application on space noise level of NC 30 maximum.

.2 Provide supply outlets with sponge rubber seal around the edge.

.3 Provide baffles to direct air away from walls, columns or other obstructions within the radius of diffuser operation.

.4 Provide plaster frame for diffusers located in plaster surfaces.

.5 Provide anti-smudge frames or plaques on diffusers located in rough textured surfaces such as acoustical plaster.

.6 Refer to Air Outlet Schedule for Specifications of air outlets.

2.2 Outside Louvers

.1 Louvers 100 mm (4 in.) deep with stationary blades on 45° slope.

.2 Each louver shall be fitted with 13 mm (1/2 in.) x 1.60 mm (0.063 in.) aluminium bird screen in a non-rewirable U-frame.

.3 Fabricate of 2.0 mm (0.081 in) extruded aluminum (6063T5) blades and frame. Provide welded assembly.

.4 Louvers shall be factory primed and finishes after assembly with a clear coat of Kynar 500 resin coating. Primer and Kynar resin coating shall be oven baked in accordance with the coating Manufacturer’s instructions.

.5 Louvers shall bear AMCA Certified Ratings Seals for air performance and water penetration ratings.

.6 Provide aluminium insect screen to the exterior frame of the louvre in a removable frame.

2.3 Gravity Hoods

.1 Air inlet or exhaust hoods shall have removable hood, curb flange and bird screen with 13 mm (1/2 in.) square mesh.

.2 Fabricate of galvanized steel minimum 1.6 mm (16 ga.) base and 1.0 mm (20 ga.) hood. Provide suitable reinforcing to hood.

.3 Mount unit on minimum 300 mm (12 in.) high curb base with insulation between duct and curb.

.4 Hood outlet area shall be minimum twice throat area.

3. EXECUTION

3.1 Priming

.1 Paint ductwork visible behind air outlets matte black.

3.2 Sizing

.1 Size outside air louvres as indicated on Drawings.

.2 Size air outlets as indicated on Drawings.

3.3 Air Outlets Schedule

.1 Refer to Equipment Schedules.

END OF SECTION

CONTROL SEQUENCES

1. GENERAL

.1 The control sequences contain a general description of the intent of the operation of the systems to be controlled. The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.

.2 The relationships between the points, systems and building are described in the control sequences.

.3 Review with the Contract Administrator during the Shop Drawing stage to finalise the control sequences for each system.

2. PRODUCTS

.1 Not Applicable

3. EXECUTION

.1 Provide database for all hardware points listed for system operation to meet Specification operating sequences.

4. CONTROL SEQUENCES

4.1 Building Heating System

.1 The heating system consists of three (3) unequal capacity water to water heat pumps **U-486-HP, U-487-HP** and **U-488-HP** dedicated to producing heating water for the air handling system coils and perimeter heaters. The heat pumps will be staged on and off with heating demand. A back-up electric boiler **U-489-EB** will be used when the UV channel is shutdown.

.1 Each heat pump is provided complete from the Manufacturer with all controls and safeties for operation and energized on and off and monitored by the central control system. Provide tie-in points to distributed control system (DCS), as indicated on the Input/Output Schedule in Division 17.

.2 The supply temperature to the building heating loop is reset linear between the following temperatures:

O/A Temp.	Supply Temp.
-40°C (-40°F)	48.9°C (120°F)
20°C (68°F)	32.2°C (90°F)

.3 The heating system shall have a warm weather shutdown, which will de-energize the circulation pumps and heating heat pumps when the outside air temperature reaches 20°C (68°F). The outside air temperature sensor shall be located on the north side of the building.

.4 The lead heat pump will be energized when the supply temperature of the fluid is 1.1°C (2°F) below the setpoint temperature of the heating system curve.

.5 The heating demand staging shall be as follows:

Equipment Tag	Stage 1 Heating	Stage 2 Heating	Stage 3 Heating	Stage 4 Heating	Stage 5 Heating	Stage 6 Heating	Stage 7 Heating
U-451-P	ON	ON	ON	ON	ON	ON	ON
U-452-P	OFF	OFF	OFF	OFF	OFF	OFF	OFF
U-481-P	ON	ON	OFF	ON	ON	ON	ON
U-482-P	OFF	OFF	ON	ON	ON	ON	ON
U-483-P	ON	ON	OFF	ON	ON	ON	ON
U-484-P	OFF	OFF	ON	ON	ON	ON	ON
U-485-P	OFF	OFF	OFF	OFF	OFF	OFF	ON
U-486-HP	OFF	OFF	ON	ON	ON	ON	ON
U-487-HP	OFF	ON	OFF	OFF	ON	ON	ON
U-488-HP	ON	OFF	OFF	ON	OFF	ON	ON
U-489-EB	OFF	OFF	OFF	OFF	OFF	OFF	ON

.6 When the hot water supply temperature exceeds the setpoint temperature on the heating system curve by 2.8°C (5°F), the heating stage shall be reduced by one (1) stage in reverse order.

.7 The heating loop pump **U-481-P** will operate continuously to allow temperature control of the heating loop.

.8 The pressure bypass valve (**PBV-2**) will be utilized to ensure minimum flow will be maintained in the heating system in the event that all of the 2 way control valves start to close during heat pump operation. This valve (PBV-1) will be normally closed until the pressure in the heating system reaches a pressure of 30 psig (209 kPag) at which time the valve will start to modulate open. The valve will modulate in a linear relationship with system pressure and it will be fully open when the heating system reaches 33 psig (224 kPag).

4.2 Back-up (Auxiliary) Heating System

.1 In the event that the heat pump system is shutdown or one of the heat pumps fails, supplemental heating will be provided to the heating system from the backup electric boiler **U-489-EB.**

.2 The backup electric boiler **U-489-EB** has a dedicated circulation pump **U-485-P,** which shall be energized when the boiler is required. The electric boiler will always be in a standby mode. The initial setpoint for the emergency heating system shall be set to 49°C (120°F).

.3 The circulation pump shall be energized if the heating glycol supply water temperature drops below 26.7°C (80°F).

.4 Alarm: An alarm shall be issued when the emergency heating system is activated.

4.3 Chilled Glycol System

.1 The chilled water system consists of five (5) water to water heat pumps dedicated to chilling water. These five (5) heat pumps will be staged on with chilled water demand. One of the larger heat pumps will be used for redundant "chiller" capacity.

.1 Each heat pump is provided complete from the Manufacturer with all controls and safeties for operation and energized on and off and monitored by the central control system. Provide tie-in points to DCS, as indicated on the Input/Output Schedule in Division 17.

.2 The chilled glycol supply temperature to building heating loop is reset linear between the following temperatures:

O/A Temp.	Supply Temp.
32.2°C (90°F)	5.6°C (42°F)
12.8°C (55°F)	12.8°C (55°F)

.3 The chilled water system shall have a cold weather shut down which will de-energize the circulation pumps and cooling heat pumps when the outside air temperature reaches 5°C (41°F). The outdoor air temperature sensor shall be located on the north side of the building.

.4 The lead heat pump 'chiller' will be energized when the chilled glycol supply temperature is 1.1°C (2°F) above setpoint temperature on the chilled water system curve.

.5 The cooling staging shall be as follows:

Equipment Tag	Stage 1 Cooling	Stage 2 Cooling	Stage 3 Cooling	Stage 4 Cooling	Stage 5 Cooling	Stage 6 Cooling	Stage 7 Cooling	Stage 8 Cooling	Stage 9 Cooling
U-451-P	ON	ON	ON	ON	ON	ON	ON	ON	ON
U-452-P	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

U-461-P	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
U-462-P	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
U-463-P	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
U-464-P	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
U-465-P	ON	ON	ON	ON	ON	ON	ON	ON	ON
U-466-P	ON	ON	ON	ON	ON	ON	ON	ON	ON
U-467-P	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON
U-468-P	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON
U-469-HP	OFF	OFF	OFF	OFF	OFF	ON	ON	ON	ON
U-470-HP	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON	ON
U-471-HP	OFF	ON	ON	ON	ON	ON	ON	ON	ON
U-472-HP	OFF	OFF	OFF	ON	ON	ON	ON	ON	ON
U-473-HP	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON

.6 When the chilled water supply temperature is below the setpoint temperature on the chilled water system curve by 1.1°C (2°F), the cooling stage shall be reduced by one (1) stage in reverse order.

.7 The cooling loop pump of the lead of these heat pumps will operate continuously to allow temperature control of the chilled glycol loop.

.8 The pressure bypass valve (**PBV-1**) will be utilized to ensure minimum flow will be maintained in the chilled glycol system in the event that all of the 2 way control valves start to close during heat pump operation. This valve (PBV-1) will be normally closed until the pressure in the heating system reaches a pressure of 30 psig (209 kPa) at which time the valve will start to modulate open. The valve will modulate in a linear relationship with system pressure and it will be fully open when the heating system reaches 33 psig (224 kPa).

4.4 Glycol Condenser Loop

.1 The glycol condenser piping loop is a closed loop piping system, which transfers the heat of rejection from the cooling heat pumps and the heat of absorption to the heating heat pumps and the effluent channel via shell and tube heat exchangers. The condenser piping loop will be maintained within a specified range of temperatures for the heat pumps to operate properly and efficiently.

.2 A temperature sensor/transmitter located in the condenser supply piping will cause the lead heat exchanger effluent pump **U-451-P** or **U-452-P** to energize or de-energize to maintain the temperature in the loop at the specified range.

.3 Condenser circulation pump **U-465-P** will run continuously for temperature control of the condenser loop.

.4 Heating season (OAT below 20°C / 68°F):

Upon the condenser supply loop temperature drops to the lower setpoint of 3.3°C (38°F), the lead effluent pump shall be energized.

Upon the condenser supply loop temperature rises to the upper setpoint of 5.6°C (42°F), the lead effluent pump shall be de-energized.

.5 Cooling season (OAT above 20°C / 68°F):

Upon the condenser loop temperature rises to the upper setpoint of 27.8°C (82°F), the lead effluent pump shall be energized.

Upon the condenser supply loop temperature drops to the lower setpoint of 25.6°C (78°F), the lead effluent pump shall be de-energized.

.6 The effluent pumps U-451-P and U-452-P shall be fully redundant to each other. The control system shall provide a weekly lead-lag changeover of U-451-P and U-452-P.

.7 The effluent pumps shall have a minimum run time of five (5) minutes to avoid excessive cycling of the pump.

.8 Alarms:

.1 An alarm shall be sent to the DCS if the condenser water temperature entering the heat exchanger drops below -3.8°C (25°F) or rises above 43.3°C (110°F).

4.5 Electrical Room Air Handling Unit (U-410-AHU-1)

.1 System Description

.1 The air-handling unit contains the primary air handling system for the electrical room and the mechanical mezzanine and a redundant 75% back-up air handling system. Each system consists individual of a supply fan, return fan, cooling coils filter section, return air damper and supply fan isolation dampers. An economizer section with a waste heat damper and exhaust air damper section and a duct reheat coil are common to both systems.

.2 System Start/Stop

.1 The primary air handling system will normally be energized by the DCS and operate to maintain the electrical room at design conditions. This system operates as a variable volume air system.

.2 Start-Up: On a signal from the DCS or remote panel selector switch the supply air isolation dampers and the return air damper will open. After the limit switches are made to indicate the supply air isolation dampers and return damper are open the supply fan and the return fan for the respective air handling section will energized. The air handling system supply and return fan will start at minimum speed as controlled through the individual fan's variable frequency drives (VFD). The outside air damper will drive to a minimum outside air position and the waste heat damper and exhaust air dampers will drive open to relieve the excess air from the space.

.3 Shutdown: On a signal from the DCS or remote panel selector switch the economizer damper will move to a normally open position. The outside air and exhaust air dampers

will move to a normally closed position. The supply fan and the return fan will de-energize and the return air damper and supply air isolation dampers will close. If the unit was in waste heat mode for the process space the process exhaust fan will de-energize and the waste heat damper on the air handling unit and the exhaust damper on the process exhaust fan will close.

.4 Refer to Division 17 for damper actuator limit switch requirements.

.3 System Setpoints:

.1 Heating: 15.6°C (60°F).

.2 Cooling: 23.9°C (75°F).

.3 Emergency Cooling: 30.6°C (87°F) on, 26.7°C (80°F) off

.4 Space Pressurization: +2 Pa (+0.008 in wg) relative to Outside.

.5 Space Pressurization: +1 Pa (+0.004 in wg) relative to UV Process area.

.4 Heating Mode:

.1 The heating mode will be activated when the space temperature in the Electrical Room, as sensed by the space heating/cooling thermostat, drops below the heating setpoint by 1.1°C (2°F).

.2 The Electrical Room the air handling unit supply and return fans will ramp up in speed. The supply fan will ramp up to 100% and the return for will ramp up to maintain the space pressure differential in relation to the ambient outside pressure.

.3 To relieve building pressure the waste heat damper will modulate open first and the exhaust air damper will remain fully closed. If the space pressure remains above the setpoint with the waste heat damper fully open, the exhaust air damper shall modulate open.

.4 The two-way control valve on the heating glycol supply will open fully for the heating coil located in the supply air discharge duct.

.5 When the space conditions are satisfied the two-way control valve on the heating coil will close. The supply and return fan will ramp down in speed. The return fan will ramp down to a minimum speed (approximately 20%) and the supply fan will ramp down to maintain the space pressure at setpoint relative to the ambient outside pressure.

.6 The ramp time for the VFD speed changes both up and down is two (2) minutes in duration.

.5 Cooling Mode:

.1 The cooling mode will be activated when the space temperature in the Electrical Room, as sensed by the space heating/cooling thermostat, rises above the cooling setpoint by 1.1°C (2°F).

.2 The Electrical Room the air handling unit supply and return fans will ramp up in speed. The supply fan will ramp up to 100% and the return for will ramp up to maintain the space pressure differential in relation to the ambient outside pressure.

.3 To relieve building pressure the waste heat damper will modulate open first and the exhaust air damper will remain fully closed. If the space pressure remains above the setpoint with the waste heat damper fully open, the exhaust air damper shall modulate open.

.4 The two-way control valve on the cooling glycol supply will modulate the flow of glycol to the coil to maintain the minimum supply air discharge temperature at 12.7°C (55°F).

.5 When the space conditions are satisfied the two-way control valve on the cooling coil will close. The supply and return fan will ramp down in speed. The return fan will ramp down to a minimum speed (approximately 20%) and the supply fan will ramp down to maintain the space pressure at setpoint relative to the ambient outside pressure.

.6 The ramp time for the VFD speed changes both up and down is 2 minutes in duration.

.6 Free Cooling Mode:

.1 The air handling unit shall utilize free cooling when the outside air conditions are suitable.

.2 When free cooling is achievable the Electrical Room the air handling unit supply and return fans will be ramped up in speed. The DCS will ensure the supply fan is ramped up to 100% and the return fan is ramped up to maintain the space pressure in relation to the ambient outside pressure.

.3 On a call for free cooling when the outside air damper and exhaust air damper will modulate open and the return damper will modulate closed to provide a mixed air temperature of 12.7°C (55°F).

.4 The two-way valve for the cooling coil will remain closed.

.7 Freeze Stats:

.1 An averaging type freeze stat shall be located on the downstream side of the glycol cooling coil. Upon sensing a low temperature the outside and exhaust air damper shall close and the return air damper shall fully open.

.8 Alarms:

.1 There shall be a low building temperature alarm signal sent to the DCS when the Electrical room space temperature drops below 4.4°C (40°F).

.2 There shall be a high building temperature alarm signal sent to the DCS when the Electrical room space temperature exceeds 29.4°C (85°F).

4.6 Electrical Room – Emergency Cooling System

.1 System Start/Stop:

.1 On a signal from emergency cooling from a cooling only thermostat located in the Electrical Room the damper for exhaust fan (U-419-EF) and the three (3) outside air intake dampers shall open .

.2 When the open limit switches on the dampers are engaged the exhaust fan will energize.

.3 When the emergency cooling system is energized the air handling system for the space shall be de-energized.

.4 When the temperature in the Electrical Room decreases to the lower setpoint, the exhaust fan will de-energize. After five (5) minutes, the motorized damper on the inlet duct to the roof mounted exhaust fan and the motorized dampers (3) for the three (3) intake air louvers in the exterior wall shall be modulated to the fully closed position (proof by limit switch). Once all four (4) motorized dampers are fully closed, the air handling system shall be energized.

.5 Alarm: An alarm shall be issued when the emergency cooling system is operational.

4.7 UV Process Room Air Handling Unit (U-420-AHU-1)

.1 System Description

.1 The air-handling unit for the UV Process room consists individual of a supply fan, return fan, cooling coil, heating coil, filter section, and economizer section.

.2 System Start/Stop

.1 The air handling system will normally be energized by the DCS and operate to maintain the UV Process Room at design conditions. This system operates as a variable volume air system.

.2 Start-Up: On a signal from the DCS the unit will prove that the outside air dampers and exhaust air dampers are closed and the economizer damper is open. When the dampers are proven to be in the proper position the return fan and the supply fan will be energized through the individual fans variable frequency drives (VFD). The outside air damper will drive to a minimum outside air position and the exhaust damper will drive open to relieve the excess air from the space.

.3 Shutdown: On a signal from the DCS or remote panel selector switch the economizer damper will move to a normally open position. The outside air and exhaust air dampers will move to a normally closed position. The supply fan and the return fan will de-energize.

.4 Refer to Division 17 for damper actuator limit switch requirements.

.3 System Setpoints:

.1 Heating: 15.6°C (60°F).

.2 Cooling: 26.7°C (80°F) resettable to 23.9°C (75°F) when occupied.

.3 Space Pressurization: +1 Pa (+0.004 in wg) relative to Outside.

.4 Space Pressurization: -1 Pa (+0.004 in wg) relative to Electrical Room.

.5 Space Relative Humidity: 45%

.4 Heating Mode:

.1 The heating mode will be activated when the space temperature in the UV Process Room, as sensed by the space heating/cooling thermostat, drops below the heating setpoint by 1.1°C (2°F).

.2 The UV Process Room the air handling unit supply and return fans will ramp up in speed. The supply fan will ramp up to 100% and the return for will ramp up to maintain the space pressure in relation to the ambient outside pressure.

.3 The two-way control valve on the heating glycol supply will modulate the flow of glycol to the coil to maintain the supply air discharge temperature of 15.6°C (60°F).

.4 On a call for heating, when the space temperature is less then setpoint be 1.1°C (2°F), the two-way control valve will fully open.

.5 When the space conditions are satisfied the two-way control valve on the heating coil will modulate to maintain a discharge air temperature of 15.6°C (60°F). The supply and return fan will ramp down in speed. The return fan will ramp down to a minimum speed (approximately 20%) and the supply fan will ramp down to maintain the space pressure at setpoint relative to the ambient outside pressure.

.6 The ramp time for the VFD speed changes both up and down is two (2) minutes in duration.

.5 Cooling Mode:

.1 The cooling mode will be activated when the space temperature in the UV Process Room, as sensed by the space heating/cooling thermostat, rises above the cooling setpoint by 1.1°C (2°F).

.2 The UV Process Room the air handling unit supply and return fans will ramp up in speed. The supply fan will ramp up to 100% and the return for will ramp up to maintain the space pressure in relation to the ambient outside pressure.

.3 The two-way control valve on the cooling glycol supply will modulate the flow of glycol to the coil to maintain the minimum supply air discharge temperature at 12.7°C (55°F).

.4 When the space conditions are satisfied the two-way control valve on the cooling coil will close. The supply and return fan will ramp down in speed. The return fan will ramp down to a minimum speed (approximately 20%) and the supply fan will ramp down to maintain the space pressure at setpoint relative to the ambient outside pressure.

.5 The ramp time for the VFD speed changes (increase or decrease) is 2 (two) minutes in duration.

.6 Free Cooling Mode:

.1 The air handling unit shall utilize free cooling when the outside air conditions are suitable.

.2 When free cooling is achievable the UV Process Room air handling unit supply and return fans will be ramped up in speed. The DCS will ensure the supply fan is ramped up to 100% and the return fan is ramped up to maintain the space pressure in relation to the ambient outside pressure.

.3 On a call for free cooling when the outside air damper and exhaust air damper will modulate open and the return damper will modulate closed to provide a mixed air temperature of 15.5°C (60°F).

.4 The two-way control valve for the cooling coil will remain closed.

.7 Freeze Stats:

.1 An averaging type freeze stat shall be located on the downstream side of the glycol heating coil. Upon sensing a low temperature the outside and exhaust air damper shall close, the economizer damper shall fully open and the heating valve for the heating coil shall fully open.

.8 Waste Heat Ventilation System:

.1 When the UV Process Room is in heating mode and the space temperature is below 20°C (68°F) the waste heat damper on U-410-AHU-1 shall modulate open (damper position controlled by electrical room space pressure).

.2 If the UV room is pressurized above 0.5 Pa, the motorized damper in the inlet duct to U-426-EF shall modulate fully open.

.3 When the dampers are proven fully open and the space is pressurized above 0.5 Pa, exhaust fan U-426-EF shall be energized and the VFD speed shall modulate to maintain this level of building pressurization.

.4 When the temperature in the UV Process Room reaches 20°C (68°F) the exhaust fan U-426-EF shall shutdown and the waste heat damper and damper for U-426-EF shall close.

.5 The UV Process Room air handling unit will be shutdown during periods using waste heat for space heating when the room temperature exceeds 20°C (68°F) and the space humidity is below 30%RH.

.9 Humidity Control:

.1 Dehumidification will only be available during heating seasons.

.2 Humidity control will be accomplished through outdoor air exchange with no mechanical dehumidification used for the controlling the humidity in the UV Process Room.

.3 When the humidity level in the UV Process Room, as measured by the sensor in the space, rises above setpoint the air handling unit outside air damper and exhaust air dampers will be modulated open and the economizer damper will be modulated closed.

.4 When the space condition is satisfied the air handling unit outside air damper and exhaust damper will modulate to minimum position and the economizer damper will modulate to maximum position.

.10 Alarms:

.1 There shall be a low building temperature alarm signal sent to the DCS when the UV Process room space temperature drops below 4.4°C (40°F).

.2 There shall be a high building temperature alarm signal sent to the DCS when the UV Process room space temperature exceeds 29.4°C (85°F).

.3 There shall be a high humidity alarm when the building humidity exceeds 80% RH.

4.8 Control Room Fan Coil Unit (U-430-AHU-1)

.1 System Description:

.1 The air-handling unit for the Control Room consists individual of a fan coil unit with supply fan, cooling coil, heating coil, filter section, and outside and return air dampers installed in the ductwork.

.2 System Start/Stop

.1 The air handling system will normally be energized by the DCS and operate to maintain the Control Room at design conditions. This system operates as a constant volume air system.

.2 Start-Up: On a signal from the DCS the unit will prove that the outside air is closed and the return air damper is open. When the dampers are proven to be in the proper position

the supply fan will be energized. The outside air damper will drive to a minimum outside air position.

.3 Shutdown: On a signal from the DCS or the return air damper will move to a normally open position and the outside air damper will move to a normally closed position. The supply fan will de-energize and all valves to the coils will close.

.4 Refer to Division 17 for damper actuator limit switch requirements.

.3 System Setpoints:

.1 Heating: 20°C (68°F).

.2 Cooling: 23.9°C (75°F).

.4 Heating Mode:

.1 The heating mode will be activated when the space temperature in the Control Room, as sensed by the space heating/cooling thermostat, drops below the heating setpoint by 1.1°C (2°F).

.2 The two-way control valve on the heating glycol supply will modulate the flow of glycol to the coil to maintain the supply air discharge temperature of 20°C (68°F).

.3 On a call for heating, when the space temperature is less then setpoint be 1.1°C (2°F), the two-way control valve will fully open.

.4 When the space conditions are satisfied the two-way control valve on the heating coil will modulate to maintain a discharge air temperature of 20°C (68°F).

.5 Cooling Mode:

.1 The cooling mode will be activated when the space temperature in the Control Room, as sensed by the space heating/cooling thermostat, rises above the cooling setpoint by 1.1°C (2°F).

.2 The two-way control valve on the cooling glycol supply will modulate the flow of glycol to the coil to maintain the minimum supply air discharge temperature at 12.8°C (55°F).

.3 When the space conditions are satisfied the two-way control valve on the cooling coil will close.

.6 Free Cooling Mode:

.1 The air handling unit shall utilize free cooling when the outside air conditions are suitable.

.2 On a call for free cooling the outside air damper will modulate open and the return damper will modulate closed of the Control Room air handling unit to provide a mixed air temperature of 15.5°C (60°F).

.3 The two-way valve for the cooling coil will remain closed.

.4 The excess exhaust air during free cooling mode will be relieved into the UV Process room via a transfer air grille.

.7 Alarms:

.1 There shall be a low building temperature alarm signal sent to the DCS when the UV Process room space temperature drops below 4.4°C (40°F).

.2 There shall be a high building temperature alarm signal sent to the DCS when the Control room space temperature exceeds 29.4°C (85°F).

4.9 Corridor/Washroom Fan Coil Unit (U-430-AHU-2)

.1 System Description:

.1 The air-handling unit for the Corridor/Washroom consists individual of a fan coil unit with supply fan, heating coil, and filter section.

.2 System Start/Stop

.1 The air handling system will normally be energized by the DCS and operate to maintain the Control Room at design conditions. This system operates as a constant volume air system.

.2 Start-Up: On a signal from the DCS or the wall thermostat the fan will be energized.

.3 Shutdown: On a signal from the DCS or the wall thermostat the supply fan will de-energize.

.3 System Setpoints:

.1 Heating: 20°C (68°F).

.4 Heating Mode:

.1 The heating mode will be activated when the space temperature in the Washroom, as sensed by the space heating thermostat, drops below the heating setpoint by 1.1°C (2°F).

.2 The heating glycol flows continuously through the heating coil.

.3 On a call for heating, when the space temperature is less then setpoint be 1.1°C (2°F), the two supply fan will be energized.

.4 When the space conditions are satisfied the supply fan will be deenergized.

.5 Alarms:

.1 There shall be a low building temperature alarm signal sent to the DCS when the UV Process room space temperature drops below 4.4°C (40°F).

4.10 Washroom Exhaust Fan (U-440-EF)

.1 The washroom will have an exhaust fan (U-440-EF-1) which will be manually controlled with a 120V wall switch.

4.11 Compressed Air Systems

.1 There are two (2) air compressors located in the mezzanine mechanical room which provide compressed air for air impact tools to be used during maintenance and for a compressed air supply to the effluent sampling building. One of the air compressors (**U-455-AC-1**) is 2.25 kW (3 hp) (600V/3ph/60Hz) and the other (**U-455-AC-2**) is 3.75 kW (5 hp) (600V/3ph/60Hz). Each air compressor has a storage tank and pressure switch. The smaller air compressor is the lead air compressor and the cut-in pressure is 621 kPag (90 psig) and the cut-out pressure is 690 kPag (100 psig). The larger air compressor is the lag air compressor and the cut-in pressure is 552 kPag (80 psig) and the cut-out pressure is 621 kPag (90 psig). Each air compressor has its own refrigerated air dryer (**U-455-AD-1 and U-455-AD-2**) which is also located in the mechanical room.

4.12 Glycol Fill Tank (U-474-GFT)

.1 There is an automatic glycol fill tank (**U-474-GFT**) located within the mechanical room for pumping up the glycol systems in the event there is a loss of glycol in the chilled glycol, heating glycol or condenser glycol systems. This tank has a built-in 120V pump which can pump the premixed glycol solution (30% E.G.) from the storage tank into these systems. The pump is manually started by plugging the cord into the nearest receptacle until the desired system fill pressure is attained (i.e., 103 kPag (15 psig)).

4.13 Trap Seal Primer System

.1 There is a trap seal primer system to maintain adequate water levels in the floor drains to prevent sanitary sewer gas from entering into the UV Disinfection facility. A solenoid valve will be timer controlled to open for five (5) minutes once every forty-eight (48) hours. The trap primer header and solenoid valve are located in the mechanical room.

4.14 Washdown Jet Pump (U-490-P)

.1 The UV Process area has a washdown pump which will pump effluent water downstream of the UV channels through a pressure tank (U-490-PT) to deliver high pressure water to a hose assembly. This pump will be manually turned on at a hand-off-auto switch located on the wall. The discharge pressure of this pump will be controlled by a pressure switch set to a cutout pressure of 483 kPag (70 psig) and a cut-in pressure of 414 kPag (60 psig). The pressure switch will be 120V, however the pump will be 600V/3ph/60Hz.

4.15 Domestic Hot Water

.1 The UV Process facility is serviced with domestic hot water from an electric hot water tank (U-480-HWT) located in the washroom. The tank has internal heating elements which are controlled by internal aquatstats to maintain the domestic hot water at 60°C (140°F).

.2 There is a domestic hot water circulation pump (U-480-DHWP) which is timer controlled to maintain relatively constant hot water temperature in the domestic hot water piping. Maintenance of a constant hot water temperature is only important for the emergency eyewash system to allow for a quicker supply of hot water in the event of an eye or face injury involving chemicals.

4.16 Sampling Building Condensate Trap Drain

.1 There is a solenoid valve located in the compressed air system to allow for purging the compressed air piping of all moisture. This solenoid valve shall be operated manually as required.

4.17 Sampling Building Exhaust Fan (U-445-EF)

.1 The sampling room will have an exhaust fan (U-445-EF) which will be manually controlled with a 120V wall switch.

END OF SECTION

TESTING, ADJUSTING AND BALANCING

1. GENERAL

1.1 Related Documents

.1 All Division 15 Specification Sections, Drawings, and general provisions of the Contract apply to Work of this Section, as do other documents referred to in this Section.

1.2 Scope

.1 The mechanical Contractor will Contract with a testing, adjusting, and balancing (TAB) agency to test, adjust, and balance the Heating, Ventilation and Air Conditioning (HVAC) systems.

.2 The Work included in this Section consists of furnishing labour, instruments, and tools required in TAB the HVAC systems, as described in these Specifications or shown on accompanying Drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

.3 The items requiring testing, adjusting, and balancing include the following:

AIR SYSTEMS:
- Air Handling Units *(U-410-AHU-1,U-420-AHU-1 and U-430-AHU-1)*
- Supply Fans
- Return Fans
- Exhaust Fans
- Zone branch and main ducts
- Diffusers, Registers and Grilles
- Coils (Air Temperatures)

HYDRONIC SYSTEMS:
- Pumps *(Circulation pumps on all heat pumps and back-up electric boiler)*
- System Mains and Branches
- Boilers *(All heat pumps and back-up electrical boiler)*
- Coils *(Air handling unit coils and reheat coils)*

1.3 Definitions, References, Standards

.1 All Work shall be accordance with the latest edition of the Associated Air Balance Council (AABC) National Standards. If these Contract Documents set forth more stringent requirements than the AABC National Standards, these Contract Documents shall prevail.

.1 AABC: The Associated Air Balance Council is a non-profit association of independent, certified agencies specializing in testing, adjusting, and balancing HVAC systems. The AABC National Standards (latest edition), provides standards and operational criteria for HVAC systems.

1.4 Qualifications

.1 Agency Qualifications: The TAB Agency shall be a current member of the Associated Air Balance Council (AABC).

1.5 Submittals

.1 Qualifications: The TAB agency shall submit a company resume listing personnel and project experience in air and hydronic system balancing and a copy of the agency's test and balance engineer (TBE) certificate.

.2 Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.

.3 Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards.

1.6 TAB Preparation and Coordination

.1 Shop Drawings, submittal data, up-to-date revisions, orders, and other data required for planning, preparation, and execution of the TAB Work shall be provided to the TAB agency no later than thirty (30) days prior to the start of TAB Work.

.2 System installation and equipment start-up shall be complete prior to the TAB agency's being notified to begin.

.3 The building control system shall be complete and operational. The Building Control System Contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

.4 All test points, balancing devices, identification tags, etc. shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

.5 Qualified installation or start-up personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.7 Reports

.1 Final TAB Report - The TAB agency shall submit the final TAB report for review by the Contract Administrator. All air outlets, devices, HVAC equipment, etc., shall be identified, along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" assuring that the project systems were tested, adjusted and balanced in accordance with the project Specifications and AABC National Standards.

.2 Refer to Division 1 for quantities of final report to submit.

1.8 Deficiencies

.1 Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

.2 The Work necessary to correct items on the deficiency listing shall be performed and verified by the Contractor before the TAB agency returns to retest. Unresolved deficiencies shall be noted in the final report.

2. PRODUCTS

2.1 Instruments

.1 All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards.

2.2 Acceptable Agencies

.1 AHS Testing & Balancing Ltd.

.2 Air Movement Services Ltd.

.3 DFC Mechanical Testing & Balancing

.4 Airdronics Ltd.

3. EXECUTION

3.1 General

.1 The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall in accordance with AABC National Standards. Adjustment tolerances shall be + or - 10% unless otherwise stated.

.2 Equipment settings, including manual damper quadrant positions, manual valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

.3 All information necessary to complete a proper TAB project and report shall be per AABC standards unless otherwise noted. The descriptions for Work required, listed in this Section, are a guide to the minimum information needed.

3.2 Air Systems

.1 The TAB agency shall verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set in the full open position. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards:

.1 For supply fans:

Fan speeds - Test and adjust fan RPM to achieve maximum or design airflow.

Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total airflow

Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 20°F or use the difference between Pitot-tube traverses of the supply and return air ducts.

Static Pressure - Test and record system static profile of each supply fan.

.2 For return fans:

Fan speeds - Test and adjust fan RPM to achieve maximum or design airflow

Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

Pitot-Tube Traverse - Perform a Pitot-tube traverse of the main return ducts to obtain total airflow.

Static Pressure - Test and record system static profile of each return fan.

.3 For exhaust fans:

Fan speeds - Test and adjust fan RPM to achieve maximum or design airflow

Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

Pitot-Tube Traverse - Perform a Pitot-tube traverse of the main exhaust ducts to obtain total airflow.

Static Pressure - Test and record system static profile of each exhaust fan.

.4 For zone, branch and main ducts:

Adjust ducts to within 5% of design airflow requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

.5 For diffusers, registers and grilles:

Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts.

Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

.6 For coils:

Air Temperature - Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

3.3 Hydronic Systems

.1 The TAB agency shall, as applicable, confirm that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards:

.1 For pumps:

Test and adjust chilled water, hot water, and condenser water pumps to achieve maximum or design flowrate. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final total dynamic head (TDH) and Block-Off/Dead head calculations.

Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

.2 For system mains and branches:

Adjust water flow in pipes to achieve maximum or design flowrate.

.3 For boilers and heat pumps:

Verify that boilers have been filled and started by others, and are in operation.

Current and Voltage - As applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.

Test and record temperature and pressure profiles of heat pumps and boilers.

.4 For coils:

Tolerances - Test, adjust, and balance all chilled-water and hot-water coils within 10% of design requirements.

Verification - Verify the type, location, final pressure drop and flowrate of each coil. This information shall be recorded on coil data sheets.

3.4 Additional TAB Services

.1 Preconstruction Plan Check and Review:

The TAB agency shall review the project documents and Contractor submittals for their effect on the TAB process and overall performance of the HVAC system. It shall submit recommendations for enhancements or changes to the system within thirty (30) days of document review.

.2 Job Site Inspections:

During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal Work, temperature controls, and other component parts of the HVAC systems. Inspections shall be conducted a minimum of two (2) times. (Typically, these are performed when 60% of the total system is installed and again when 90% of the total system is installed, prior to insulation of the duct and piping). The TAB agency shall submit a written report of each inspection.

.3 Verification of HVAC Controls:

The TAB agency shall be assisted by the building control systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.

Verify that all controlling instruments are calibrated and set for design operating conditions.

.4 Temperature Testing

To verify system control and operation, a series of three (3) temperature tests shall be taken at approximately two (2) hour intervals in each separately controlled zone. The

resulting temperatures shall not vary more than 1.1°C (2°F) from the thermostat or control setpoint during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

.5 Fire and Smoke Testing:

The TAB agency shall test fire/smoke dampers to assure operation. It shall verify that an access door has been installed for each fire and smoke damper. For fire dampers, the TAB agency shall open the access door, disconnect the fusible link, and allow the damper to close. Operation should be smooth and the damper must close completely. The TAB agency shall then reset the damper. For the smoke damper, the TAB agency shall open the access door, activate the damper, and observe operation. The damper must close quickly and completely. The TAB agency shall then reset the damper and observe its complete opening.

END OF SECTION

1. LIST OF SCHEDULES

.1 Air Handling Unit Schedule

.2 Exhaust Air Fan Schedule

.3 Hydronic Heat Exchange Schedule

.4 Heating Coil Schedule

.5 Pump Schedule

.6 Grilles, Registers and Diffusers

.7 Louver Schedule

.8 Air Compressor Schedule

.9 Air Drier Schedule

.10 Domestic Hot Water Tank Schedule

.11 Variable Frequency Drive Schedule

.12 Tank Schedule (Expansion, Glycol Fill, Pressure Tank)

.13 Heat Pump Schedule

.14 Gravity Hood Schedule

.15 Boiler Schedule

LIST OF SCHEDULES

1.1 Air Handling Unit Schedule

Tag	U-410-AHU-1		U-420-AHU-1
Location	Mechanical Mezzanine		UV Room 105
Area Served	Electrical Room 103		UV Room 105
Type	Draw Through		Draw Through
Manufacturer	Haakon		McQuay
Model	CUSTOM		CAH012FDAC
Supply Fan			
Tag	U-416-SF	U-417-SF	U-424-SF
Volume – l/s (cfm)	4720 (10,000)	6,135 (13,000)	2,600 (5,500)
ESP – Pa (in.wg.)	300 (1.2)	300 (1.2)	275 (1.1)
Fan Type	20" DWDI-AF	24" DWDI-AF	12" FC
Fan Speed (rpm)	1931	1499	1233
Motor Power – kW (hp)	11.2 (15)	14.9 (20)	3.7 (5)
Power Supply	575/3/60	575/3/60	575/3/60
Return Fan			
Tag	U-411-RF	U-412-RF	U-421-RF
Volume – l/s (cfm)	4,720 (10,000)	6,135 (13,000)	2600 (5500)
ESP – Pa (in.wg.)	200 (0.8)	200 (0.8)	175 (0.7)
Fan Type	22" DWDI-AF	24" DWDI-AF	12" FC
Fan Speed (rpm)	1276	1199	1187
Motor Power – kW (hp)	7.5	10	3.7 (5)
Power Supply	575/3/60	575/3/60	575/3/60
Minimum Outdoor Air (cfm)	100	100	200
Heating Coil			
Tag			U-420-HC
Heating Cap. – kW (MBH)			56.2 (192)
Fluid			30% E.G.
Flow Rate – l/s (usgpm)			(2.60) 41.2
Water ΔP – kPa (ft Hd)			15.8 (5.3)
EWT - °C (°F)			29.4 (85)
LWT - °C (°F)			23.7 (74.9)
Entering Air Temp. – °F (°C)			30 (-1.1)
Leaving Air Temp – °F (°C)			62.9 (17)
Cooling Coil			
Tag	U-416-CC	U-417-CC	U-420-CC
Size, H x L ***(in)****(mm)*	2 @ 36x40	2 @ 36x52	33x53
Face Area ***(ft²)****(m²)*	2 @ 10 (2 @ 0.93)	2 @ 13 (2 @ 1.21)	12.15 (1.13)
Rows / FPI	6/11	6/11	3/8
Face Velocity ***(fpm)****(m/s)*	500	500	453
Water side P.D. (***ft Hd)****(kPa)*	4.3 (12.8)	5.4 (16.1)	1.8 (5.4)
Flow rate l/s **(gpm)**	(2.76 l/s x2) (34.6x2)	(2.91x2) (46.1x2)	0.98 (15.6)
EAT DB/WB ***(°F)****(ºC)*	80/67 (26.7/19.4)	80/67 (26.7/19.4)	80/67 (26.7/19.4)
LAT DB/WB ***(°F)****(ºC)*	55.4/55.2 (13.0/12.9)	56/55.7 (13.3/13.2)	67.5/63.0 (19.7/17.2)
EWT °F (°C)	44	44	46.5 (8.1)
LWT °F (°C)	55.4	54.7	56.6 (13.7)
Fluid	30% E.G.		30% E.G.
Physical Data			
Overall Length ***(mm)****(in)*	7170 (282)		5180 (204)
Overall Width ***(mm)****(in)*	3130 (123)		1680 (66)
Overall Height ***(mm)****(in)*	3010 (118)		1070 (42)
Overall Weight *(kg)* ***(lb)***	7730 (17050)		1590 (3500)

1.1 Air Handling Unit Schedule (cont'd)

LIST OF SCHEDULES

Tag	U-430-AHU-1	U-430-AHU-2
Location	Corridor 101	Corridor 101
Area Served	Control 102	Corridor/WC
Type	Fan Coil	Fan Coil
Manufacturer	McQuay	McQuay
Model	F-THC-1-H06	F-THC-1-H06
Supply Fan		
Tag	U-432-SF	U-434-SF
Volume – l/s (cfm)	189 (400)	189 (400)
ESP – Pa (in.wg.)	75 (.30)	75 (.30)
Fan Type	Centrifugal-FC	Centrifugal-FC
Fan Speed (rpm)	1181	1181
Motor Power – kW (hp)	0.205 (0.275)	0.205 (0.275)
Power Supply	115/1/60	115/1/60
Return Fan		
Tag		
Volume – l/s (cfm)		
ESP – Pa (in.wg.)		
Fan Type		
Fan Speed (rpm)		
Motor Power – kW (hp)		
Power Supply		
Minimum Outdoor Air (cfm)	40	0
Heating Coil		
Tag	U-430-HC	U-430-HC-1
Heating Cap. – kW (MBH)	2.69 (9.2)	2.69 (9.2)
Fluid	30% E.G.	30% E.G.
Flow Rate – l/s (usgpm)	0.15 (2.4)	0.15 (2.4)
Water ΔP – kPa (ft Hd)	36 (12)	36 (12)
EWT - °C (°F)	43.3 (110)	43.3 (110)
LWT - °C (°F)	37.8 (102)	37.8 (102)
Entering Air Temp. – °F (°C)	60 (15.56)	60 (15.56)
Leaving Air Temp – °F (°C)	81.7 (27.6)	81.7 (27.6)
Cooling Coil		
Tag	U-430-CC	
Size, H x L ***(in)****(mm)*	6x72 (150x1800)	
Face Area ***(ft²)****(m²)*	3.00 (.278)	
Rows / FPI	3/6	
Face Velocity ***(fpm)****(m/s)*	150	
Water side P.D. (***ft Hd)****(kPa)*	5 (14.9)	
Flow rate l/s **(gpm)**	0.29 (4.6)	
EAT DB/WB ***(°F)****(ºC)*	80/67 (26.7/19.4)	
LAT DB/WB ***(°F)****(ºC)*	62/59.8 (16.67/15.44)	
EWT °F (°C)	46.5 (8.1)	
LWT °F (°C)	50.9 (10.5)	
Fluid	30% E.G.	
Physical Data	4 pipe	2 pipe
Overall Length ***(mm)****(in)*	556 (21.9)	556 (21.9)
Overall Width ***(mm)****(in)*	1314 (51.73)	1314 (51.73)
Overall Height ***(mm)****(in)*	251 (9.88)	251 (9.88)
Overall Weight *(kg)* ***(lb)***	46 (102)	44 (97)

1.2 Exhaust Air Fan Schedule

LIST OF SCHEDULES

Tag	U-419-EF	U-426-EF	U-440-EF	U-445-EF
Function	Backup Cooling	Relief Air	Exhaust Air	Exhaust Air
Area Served	Electrical Room	UV Room	Washroom	Sampling Building
Location	Roof	Roof	Washroom	Sampling Building
Volume *L/S* ***(cfm)***	16500 (35000)	2600 (5500)	50 (100)	50 (100)
E.S.P. Press ***(in.wg.)****(Pa)*	0.5”(125)	0.75”(187)	0.5”(125)	0.5”(125)
RPM	410	775	2800	2800
Motor Power ***(HP)****(KW)*	15 (11.2)	1.5 (1.1)	0.12 (0.087)	0.12 (0.087)
Power Supply (V/Ph/Hz)	575/3/60	575/3/60	115/1/60	115/1/60
Drive	Belt	Belt	Direct	Direct
Type	Dome	Dome	Inline	Inline
Arrangement	Roof mounted w/ curb	Roof mounted w/ curb	Horizontal	Horizontal
Manufacturer	Domex	Domex	Centrex Rex Jr.	Centrex Rex Jr.
Model	MB542	DX24B	REX05JX	REX05JX
Control	DDC to SCADA	DDC to SCADA	On-Off	On-Off
Accessories & Remarks	10	10	10, 11	10, 11

Accessories : (Select Appropriate)

1. Gasketted bolted access door
2. Housing drain with plug
3. Totally enclosed belt guard
4. Shaft and bearing guard
5. Extended grease fittings
6. Fan base and vibration isolators
7. Weatherproof motor
8. Drive cover
9. Shaft seal
10. Bird Screen
11. Back draft damper

1.3 Hydronic Heat Exchanger Schedule

Tag	U-453-HX	U-454-HX
Function		
Location	UV Room	UV Room
Type	Shell and Tube	Shell and Tube
Shell Side Data		
Medium	Effluent	Effluent
Design Flow ***(USgpm)****(L/S)*	120 (7.57)	120 (7.57)
Entering Temp ***(ºF)****(ºC)*	68 (20)	68 (20)
Leaving Temp ***(ºF)****(ºC)*	77.3 (25.2)	77.3 (25.2)
Pressure Drop ***(psi)****(kPa)*	5.7 (39.3)	5.7 (39.3)
Tube Side Data		
Medium	30% E.G.	30% E.G.
Design Flow ***(USgpm)****(L/S)*	120 (7.57)	120 (7.57)
Entering Temp ***(ºF)****(ºC)*	90 (32.2)	90 (32.2)
Leaving Temp ***(ºF)****(ºC)*	80 (26.7)	80 (26.7)
Pressure Drop ***(psi)****(kPa)*	5.6 (38.6)	5.6 (38.6)
Dimensions WxHxL ***(in)****(mm)*	10.75x10.75x149 (273x273x3785)	10.75x10.75x149 (273x273x3785)
Max. Design Press. ***(psi)****(kPa)*	150 (1035)	150 (1035)
Manufacturer	Bell & Gossett	Bell & Gossett
Model	WU1012-4 5	WU1012-4 5
Accessories & Remarks	Stainless steel tubes	Stainless steel tubes

1.4 Heating Coil Schedule

Tag	U-410-HC
Location	Mezzanine Mechanical
Installation	In duct
Total Capacity ***(MBH)****(KW)*	121.4 (35.58)
Air Data	
Airflow ***(L/S)****(cfm)*	6132 (13,000)
EAT ***(°F)****(°C)* db	55 (12.8)
LAT ***(°F)****(°C)* db	63.8 (17.7)
Media	
Total F.A. ***(sq. ft.)****(m^2)*	14 (1.3)
Max. F.V. ***(fpm)****(m/s)*	929 (283)
Arrangement	
HT/Coil ***(in)****(mm)*	42 (1050)
LEN/Coil ***(in)****(mm)*	48 (1200)
Rows	1
Fin. Spacing (F/300 ***(ft)****(mm)*	14
Max. Water P.D. ***(fthd)****(kPa)*	7.2 (21.5)
Max. Air P.D. ***(in. wg)****(Pa)*	0.35 (87)
Remarks	

1.5 Pump Schedule

Tag	**U-451-P**	**U-452-P**	**U-490-P-1**
Function	Heat Exchanger Loop	Heat Exchanger Loop	Washdown
Location	UV Process Room	UV Process Room	UV Process Room
Type	Self Priming Centrifugal	Self Priming Centrifugal	Multistage Jet Pump
Manufacturer	Marlow – ITT Industries	Marlow – ITT Industries	Berkeley
Model	M2PL1EL 2 B 3 A 0	M2PL1EL 2 B 3 A 0	CP
Pump			
Impeller – mm (in)	175 (6.88)	175 (6.88)	
Casing			
Suction/Discharge Sizes – ” NPT	2” / 2”	2” / 2”	2” / 1.5”
Design Pressure – kPa (psi)	860 (125)	860 (125)	690 (100)
Operating Conditions			
Capacity – l/s (usgpm)	7.57 (120)	7.57 (120)	0.63 (10)
Suction Lift – kPa (psig)	2.43 (8)	2.43 (8)	4.86 (6.9)
Discharge Pressure – kPa (psig)			414 (60)
Total Head – m (ft)	12.2 (40)	12.2 (40)	461 (154)
Hydraulic Power - hp			2.5
NPSH Available – m (ft)			
RPM	1750	1750	3400
Efficiency	67	67	
Service	Continuous	Continuous (standby)	Intermittent
Fluid			
Type	Effluent	Effluent	Final Effluent
Temperature - °C (°F) Rated	20 (68)	20 (68)	25 (77)
Max	21 (70)	21 (70)	30 (80)
Specific Gravity Rated			
Max			
Viscosity - cp Rated			
Max			
Motor			
Motor Power – kW (hp)	1.49 (2)	1.49 (2)	1.89 (2.5)
Power Supply (V/ph/Hz)	575/3/60	575/3/60	575/3/60
Enclosure	ODP	ODP	ODP

1.5 Pump Schedule (cont'd)

Tag		**U-461-P**	**U-462-P**	**U-463-P**
Function		Condenser Loop	Chilled Glycol	Condenser Loop
Location		Mezzanine	Mezzanine	Mezzanine
Type		Inline Close Coupled	Inline Close Coupled	Inline Close Coupled
Manufacturer		Bell & Gossett	Bell & Gossett	Bell & Gossett
Model		90	90	90
Pump				
Impeller – mm (in)		111 (4.375)	121 (4.75)	111 (4.375)
Casing				
Suction/Discharge Sizes – " NPT		1-1/4" / 1-1/4"	1-1/4" / 1-1/4"	1-1/4" / 1-1/4"
Design Pressure – kPa (psi)		860 (125)	860 (125)	860 (125)
Operating Conditions				
Capacity – l/s (usgpm)		2.2 (35)	2.2 (35)	2.2 (35)
Suction Pressure – kPa (psig)				
Discharge Pressure – kPa (psig)				
Differential Head – m (ft)		179 (60)	145 (70)	145 (60)
Hydraulic Power - hp		1.14	1.3	1.14
NPSH Available – m (ft)				
RPM		3450	3450	3450
Efficiency		47.57%	47%	47.57%
Service		Continuous	Continuous	Continuous
Fluid				
Type		30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Temperature - °C (°F)	Rated	15.6 (60)	10 (50)	35 (95)
	Max	29.4 (85)	12.8 (55)	29.4 (85)
Specific Gravity	Rated	1.04	1.04	1.03
	Max	1.03	1.04	1.03
Viscosity - cp	Rated	2.51	2.00	1.45
	Max	1.66	1.66	1.66
Motor				
Motor Power – kW (hp)		1.1 (1.5)	1.49 (2)	1.1 (1.5)
Power Supply (V/ph/Hz)		575/3/60	575/3/60	575/3/60
Enclosure		ODP	ODP	ODP

1.5 Pump Schedule (cont'd)

Tag		**U-464-P**	**U-465-P**	**U-466-P**
Function		Chilled Glycol Loop	Condenser Loop	Chilled Glycol Loop
Location		Mezzanine	Mezzanine	Mezzanine
Type		Inline Close Coupled	Inline Close Coupled	Inline Close Coupled
Manufacturer		Bell & Gossett	Bell & Gossett	Bell & Gossett
Model		90	90	90
Pump				
Impeller – mm (in)		121 (4.75)	117 (4.625)	114 (4.5)
Casing				
Suction/Discharge Sizes – " NPT		1-1/4" / 1-1/4"	1-1/4" / 1-1/4"	1-1/2" / 1-1/2"
Design Pressure – kPa (psi)		860 (125)	860 (125)	860 (125)
Operating Conditions				
Capacity – l/s (usgpm)		2.2 (35)	3.15 (50)	3.15 (50)
Suction Pressure – kPa (psig)				
Discharge Pressure – kPa (psig)				
Differential Head – m (ft)		145 (70)	21.3 (60)	21.3 (70)
Hydraulic Power - hp		1.3	1.42	1.79
NPSH Available – m (ft)				
RPM		3450	3450	3450
Efficiency		47%	55.17%	52.06%
Service		Continuous	Continuous	Continuous
Fluid				
Type		30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Temperature - °C (°F)	Rated	10 (50)	-3.9 (25)	35 (95)
	Max	12.8 (55)	37.8 (100)	37.8 (100)
Specific Gravity	Rated	1.04	1.04	1.03
	Max	1.04	1.05	1.03
Viscosity - cp	Rated	2.00	5.50	1.45
	Max	1.66	5.50	1.35
Motor				
Motor Power – kW (hp)		1.49 (2)	1.5 (2)	2.25 (3)
Power Supply (V/ph/Hz)		575/3/60	575/3/60	575/3/60
Enclosure		ODP	ODP	ODP

1.5 Pump Schedule (cont'd)

Tag	**U-467-P**	**U-468-P**	**U-481-P**
Function	Condenser Loop	Chilled Glycol Loop	Condenser Loop
Location	Mezzanine	Mezzanine	Mezzanine
Type	Inline Close Coupled	Inline Close Coupled	Inline Close Coupled
Manufacturer	Bell & Gossett	Bell & Gossett	Bell & Gossett
Model	90	90	90
Pump			
Impeller – mm (in)	111 (4.375)	121 (4.75)	111 (4.375)
Casing			
Suction/Discharge Sizes – " NPT	1-1/4" / 1-1/4"	1-1/4" / 1-1/4"	1-1/4" / 1-1/4"
Design Pressure – kPa (psi)	860 (125)	860 (125)	860 (125)
Operating Conditions			
Capacity – l/s (usgpm)	2.2 (35)	2.2 (35)	2.2 (35)
Suction Pressure – kPa (psig)			
Discharge Pressure – kPa (psig)			
Differential Head – m (ft)	21.3 (60)	21.3 (70)	21.3 (60)
Hydraulic Power - hp	1.14	1.3	1.14
NPSH Available – m (ft)			
RPM	3450	3450	3450
Efficiency	47.57%	47%	47.57%
Service	Continuous	Continuous	Continuous
Fluid			
Type	30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Temperature - °C (°F) Rated	35 (95)	15.6 (60)	35 (95)
Max	37.8 (100)	37.8 (100)	37.8 (100)
Specific Gravity Rated	1.03	1.04	1.05
Max	1.03	1.03	1.03
Viscosity - cp Rated	1.45	2.51	1.45
Max	1.35	1.35	1.35
Motor			
Motor Power – kW (hp)	1.1 (1.5)	1.5 (2)	1.1 (1.5)
Power Supply (V/ph/Hz)	575/3/60	575/3/60	575/3/60
Enclosure	ODP	ODP	ODP

1.5 Pump Schedule (cont'd)

Tag		**U-482-P**	**U-483-P**	**U-484-P**
Function		Heating Glycol Loop	Condenser Loop	Heating Glycol Loop
Location		Mezzanine	Mezzanine	Mezzanine
Type		Inline Close Coupled	Inline Close Coupled	Inline Close Coupled
Manufacturer		Bell & Gossett	Bell & Gossett	Bell & Gossett
Model		90	90	90
Pump				
Impeller – mm (in)		121 (4.75)	111 (4.375)	121 (4.75)
Casing				
Suction/Discharge Sizes – " NPT		1-1/4" / 1-1/4"	1-1/4" / 1-1/4"	1-1/4" / 1-1/4"
Design Pressure – kPa (psi)		860 (125)	860 (125)	860 (125)
Operating Conditions				
Capacity – l/s (usgpm)		2.2 (35)	2.2 (35)	2.2 (35)
Suction Pressure – kPa (psig)				
Discharge Pressure – kPa (psig)				
Differential Head – m (ft)		21.3 (70)	21.3 (60)	21.3 (70)
Hydraulic Power - hp		1.35	1.14	1.35
NPSH Available – m (ft)				
RPM		3450	3450	3450
Efficiency		48.09%	47.57%	48.09%
Service		Continuous	Continuous	Continuous
Fluid				
Type		30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Temperature - °C (°F)	Rated	43.3 (110)	15.6 (60)	43.3 (110)
	Max	48.9 (120)	37.8 (100)	48.9 (120)
Specific Gravity	Rated	1.02	1.05	1.02
	Max	1.02	1.03	1.02
Viscosity - cp	Rated	1.20	2.51	1.20
	Max	1.00	1.35	1.00
Motor				
Motor Power – kW (hp)		1.5 (2)	1.1 (1.5)	1.5 (2)
Power Supply (V/ph/Hz)		575/3/60	575/3/60	575/3/60
Enclosure		ODP	ODP	ODP

1.5 Pump Schedule (cont'd)

Tag	SPARE-1	SPARE-2	U-485-DHWP	U-485-P
Function	Heat/Chill Glycol	Condensor	DHW Recirc	Heating Loop
Location	Mezzanine	Mezzanine	Washroom	Mezzanine
Type	Inline CC	Inline CC	Inline	Inline
Manufacturer	Bell & Gossett	Bell & Gossett	Grundfos	Grundfos
Model	90	90	UP15-	UP32-160 F B
Pump				
Impeller – mm (in)	121 (4.75)	111 (4.375)		
Casing				
Suction/Discharge Sizes – " NPT	1-1/4" / 1-1/4"	1-1/4" / 1-1/4"	½"	2" / 2"
Design Pressure – kPa (psi)	860 (125)	860 (125)	1000 (145)	1000 (145)
Operating Conditions				
Capacity – l/s (usgpm)	2.2 (35)	2.2 (35)	0.17 (2.7)	0.946 (15)
Suction Pressure – kPa (psig)				
Discharge Pressure – kPa (psig)				
Differential Head – m (ft)	21.3 (70)	21.3 (60)	0.30 (1)	13.7 (45)
Hydraulic Power - hp	1.35	1.14		0.5
NPSH Available – m (ft)				
RPM	3450	3450		1750
Efficiency	48.09%	47.57%		
Service	Continuous	Continuous	Intermittent	Continuous
Fluid				
Type	30% Ethylene	30% Ethylene	DHW	30% Ethylene
Temperature - °C (°F) Rated	43.3 (110)	15.6 (60)	60 (140)	49 (125)
C / F Max	48.9 (120)	37.8 (100)	66 (150)	93 (200)
Specific Gravity Rated	1.02	1.05	1.00	1.03
Max	1.02	1.03		1.03
Viscosity - cp Rated	1.20	2.51		1.45
Max	1.00	1.35		1.35
Motor				
Motor Power – kW (hp)	1.5 (2)	1.1 (1.5)	0.025 (0.034)	0.6 (0.8)
Power Supply (V/ph/Hz)	575/3/60	575/3/60	115/1/60	208/3/60
Enclosure	ODP	ODP		ODP

LIST OF SCHEDULES

1.6 Grilles, Registers and Diffusers Schedule

Tag	Manufacturer Model No.	Border/Frame	Core	Module Size (mm)	Neck Size (mm)	Finish	Fastening	Options	Remarks
S-1	E.H. Price 600 series		Dbl. Defl.	See Drwgs	See Drwgs	5	Counter-sunk screw		
S-2	E.H. Price 700 series		Dbl. Defl.	See Drwgs	See Drwgs		Counter-sunk screw		Stainless steel
R-1	E.H. Price 600 series		Dbl. Defl.	See Drwgs	See Drwgs	2	Counter-sunk screw		
R-2	E.H. Price 82 series		Egg-crate	See Drwgs	See Drwgs	2	Counter-sunk screw		
DG-1	E.H. Price ATG1			See Drwgs	N/A	2			
E-1	E.H. Price 82 Series		Egg-crate	See Dwgs	See Dwgs	5	Counter sunk screw		
E-2	E.H. Price 82 Series		Egg-crate	See Dwgs	See Dwgs	5	Counter sunk screw		

Finishes:
1. Off-white baked enamel
2. Aluminum baked enamel
3. Aluminum prime coat
4. Brushed finish and clear acrylic coat
5. White baked enamel
6. White powder coat

1.7 Louver Schedule

Tag	Manufacturer Model No.	Frame	Core	Size – mm (in) Width x Height	Cap. – l/s (cfm)	Vel. – m/s (fpm)	ΔP – Pa (in)	Fast.	Finishes	Options
L-1	Airolite 638C1004X		Storm-proof	See Dwgs.	See Dwgs.	245 (800)	25 (.1)	Mtg angle	2	1,2

LIST OF SCHEDULES

Finishes : 1. Baked enamel 3. Duranar XL
2. Duranar 4. Match adjacent panelling

Options : 1. Formed metal sill 3. Aluminum bird screen
2. Aluminum insect screen 4. Removable access door

1.8 Air Compressor Schedule

Tag No.	U-455-AC-1	U-455-AC-2
Location	Mechanical Mezz.	Mechanical Mezz.
Area Served	UV Disinfection Area	UV Disinfection Area
Type	Reciprocating, Single stage, packaged	Reciprocating, Single stage, packaged
Manufacturer	Quincy	Quincy
Model	QTSV-3-30	QTSV-5-30
Compressor		
Bore (mm)	70	70
Stroke (mm)	50	50
Number of Cylinders	2	2
Speed (RPM)	665	990
Piston Displacement (L/s)	4.3	6.4
Displacement @ 175 psi (L/s)	?	?
Motor		
Type	Electric	Electric
Power (hp)	3	5
Voltage/Ph/Hz	600/3/60	600/3/60
Air Receiver		
Size, ∅ - mm	475	475
Volume – L	114	114
Discharge Connection – NPT	?	?
Physical Data		
Overall Length – mm	675	675
Overall Height – mm	1075	1075
Overall Weight – kg	77	77
Acceptable Manufacturers	Ingersoll-Rand	Ingersoll-Rand
	Gardner Denver	Gardner Denver
	Champion	Champion

LIST OF SCHEDULES

1.9 Air Dryer Schedule

Tag No.	U-455-AD-1	U-455-AD-2
Location	Mechanical Mezz.	Mechanical Mezz.
Area Served	UV Disinfection Area	UV Disinfection Area
Type	Refrigerated Air Dryer	Refrigerated Air Dryer
Manufacturer	ZEKS	ZEKS
Model	10 NCC	10 NCC
Capacity (38F)	10	10
Length in (mm)	14 (360)	14 (360)
Depth in (mm)	13 (330)	13 (330)
Height in (mm)	15 (380)	15 (380)
Shipping Weight lbs (kg)	50 (23)	50 (23)
Air connection In & Out	1 / 2 in FPT	1 / 2 in FPT
Drain	1 / 8 in NPT	1 / 8 in NPT
Motor		
Type	Electric	Electric
Power (hp)	1 / 5	1 /5
Voltage/Ph/Hz	115/1/60	115/1/60
Max Working Pressure psig (kPa)	250 (1724)	250 (1724)

1.10 Domestic Hot Water Tank Schedule

Tag	U-480-HWT-1
Service	Domestic Hot Water
Location	Washroom
Manufacturer	Rheem
Model	RHEM PRO620-T
Dimensions	
Capacity **L** (usgal.)	270 (60)
Height **mm** (in.)	1375 (55)
Diameter **mm** (in.)	606 (24-1/4)
Electrical Input – kW	7.6
Recovery Rate @ 32°C (90°F) Rise– **L/hr** (gph)	67.1 (18)
Electrical (V/ph/Hz)	208/1/60
Stages	2 – 3.8 kW
Remarks	c/w T&P valve

LIST OF SCHEDULES

1.11 Variable Frequency Drive Schedule

Tag	U-416-VFD	U-417-VFD
Service	U-416-SF	U-417-SF
Driven Motor ***(Hp)(KW)***	11.2 (15)	14.9 (20)
Power Supply (V/ph/Hz)	575/3/60	575/3/60
Manufacturer	Danfoss Graham	Danfoss Graham
Model No.	VLT 6000	VLT 6000

Tag	U-411-VFD	U-412-VFD
Service	U-411-RF	U-412-RF
Driven Motor ***(Hp)(KW)***	5 (3.7)	7.5 (5.6)
Power Supply (V/ph/Hz)	575/3/60	575/3/60
Manufacturer	Danfoss Graham	Danfoss Graham
Model No.	VLT 6000	VLT 6000

Tag	U-424-VFD	U-421-VFD
Service	U-424-SF	U-421-RF
Driven Motor ***(Hp)(KW)***	5 (3.7)	5 (3.7)
Power Supply (V/ph/Hz)	575/3/60	575/3/60
Manufacturer	Danfoss Graham	Danfoss Graham
Model No.	VLT 6000	VLT 6000

Tag	U-426-VFD
Service	U-426-EF
Driven Motor ***(Hp)(KW)***	1.5 (1.1)
Power Supply (V/ph/Hz)	575/3/60
Manufacturer	Danfoss Graham
Model No.	VLT 6000

LIST OF SCHEDULES

1.12 Tank Schedule

Tag	U-470-EXP-1	U-460-EXP-2	U-460-EXP-3
Service	Expansion Tank – Heating Glycol	Expansion Tank – Chilled Glycol	Expansion Tank – Condensor Glycol
Location	Mech. Mezz. Room	Mech. Mezz. Room	Mech. Mezz. Room
Type	Diaphragm	Diaphragm	Diaphragm
Acceptance Volume ***(USgal)****(litre)*	2.4 *(9.1)*	2.4 *(9.1)*	11.3 *(42.8)*
Tank Volume (USG)/litre	8.0 *(30.3)*	8.0 *(30.3)*	21.7 *(82.1)*
Diameter/Length ***(in)****(mm)*	**12/19.25** *(305/489)*	**12/19.25** *(305/489)*	**16.25/29** *(413/737)*
Manufacturer	Bell & Gossett	Bell & Gossett	Bell & Gossett
Model	D-15	D-15	D-40
Accessories & Remarks	High Capacity Air Vent		

Tag	U-474-GFT	U-490-PT
Service	Glycol Fill Tank	Pressure Tank
Location	Mech. Mezz. Room	UV Process
Type	Electric	Diaphragm
Tank Volume ***(USgal)****(litre)*	53 *(196)*	25 (95)
Electrical Supply	120/1/60	c/w 115V pressure switch
Maximum Working Pressure (psi/kPa)	125 / 850	150 / 1034
Manufacturer	Armstrong	Amtrol Well-X-Trol
Model	GLA-STD-LP-1	WX-402
Accessories & Remarks	Manual Operation	0.45 Acceptance Factor

LIST OF SCHEDULES

1.13 Water Source Heat Pump Schedule

Tag	U-469-HP	U-470-HP	U-471-HP
Service	Chilled Glycol	Chilled Glycol	Chilled Glycol
Type	Water to Water	Water to Water	Water to Water
Location	Mechanical Mezz.	Mechanical Mezz.	Mechanical Mezz.
Manufacture	Ice Kube	Ice Kube	Ice Kube
Model	IKS144	IKS144	IKS144
Unit Dimensions – HxWxD mm (inches)	99 x 692 x 692 25.5 x 27.25 x 27.25	99 x 692 x 692 25.5 x 27.25 x 27.25	99 x 692 x 692 25.5 x 27.25 x 27.25
Source Side Data			
Fluid Flow – L/s (gpm)	2.21 (35)	2.21 (35)	2.21 (35)
Pressure Drop – kPa (ft)	84 (28)	84 (28)	84 (28)
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Load Side Data			
Fluid Flow – L/s (gpm)	2.21 (35)	2.21 (35)	2.21 (35)
Pressure Drop – kPa (ft)	84 (28)	84 (28)	84 (28)
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Source Side Heating Data			
Heat Rejection – kW (MBH)			
EST - °C (°F)			
LST - °C (°F)			
Load Side Heating Data			
Heating Cap–kW (MBH)			
Electrical Power Draw – kW			
COP			
ELT - °C (°F)			
LLT - °C (°F)			
Source Side Cooling Data			
Heat Rejection – kW (MBH)			
EST - °C (°F)	25 (77)	25 (77	25 (77)
LST - °C (°F)	29.4 (85)	29.4 (85)	29.4 (85)
Load Side Cooling Data			
Cooling Capacity – kW (MBH)	39.8 (135.7)	39.8 (135.7)	39.8 (135.7)
Electrical Power Draw – kW	8.7	8.7	8.7
EER	15.6	15.6	15.6
ELT - °C (°F)	8.1 (46.5)	8.1 (46.5)	8.1 (46.5)
LLT - °C (°F)	12 (53.6)	12 (53.6)	12 (53.6)
Power Supply (V/Ph/Hz)	575/3/60	575/3/60	575/3/60

LIST OF SCHEDULES

Minimum Circuit Ampacity (MCA)	16	16	16

1.13 Water Source Heat Pump Schedule (cont'd)

Tag	U-472-HP	U-473-HP	
Service	Chilled Glycol	Chilled Glycol	
Type	Water to Water	Water to Water	
Location	Mechanical Mezz.	Mechanical Mezz.	
Manufacture	Ice Kube	Ice Kube	
Model	IKS144	IKS060	
Unit Dimensions – HxWxD mm (inches)	99 x 692 x 692 25.5 x 27.25 x 27.25	99 x 692 x 692 25.5 x 27.25 x 27.25	
Source Side Data			
Fluid Flow – L/s (gpm)	2.21 (35)	0.95 (15)	
Pressure Drop – kPa (ft)	84 (28)	84 (28)	
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	
Load Side Data			
Fluid Flow – L/s (gpm)	2.21 (35)	0.95 (15)	
Pressure Drop – kPa (ft)	84 (28)	84 (28)	
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	
Source Side Heating Data			
Heat Absorption – kW (MBH)			
EST - °C (°F)			
LST - °C (°F)			
Load Side Heating Data			
Heating Capacity–kW (MBH)			
Electrical Power Draw – kW			
COP			
ELT - °C (°F)			
LLT - °C (°F)			
Source Side Cooling Data			
Heat Rejection – kW (MBH)			
EST - °C (°F)	25 (77)	25 (77)	
LST - °C (°F)	29.4 (85)	29.4 (85)	
Load Side Cooling Data			
Cooling Capacity – kW (MBH)	39.8 (135.7)	17.4 (59.3)	
Electrical Power Draw – kW	8.7	3.21	
EER	15.6	21.48	
ELT - °C (°F)	8.1 (46.5)	8.1 (46.5)	

LIST OF SCHEDULES

LLT - °C (°F)	12 (53.6)	12 (53.6)	
Power Supply (V/Ph/Hz)	575/3/60	575/3/60	
Minimum Circuit Ampacity (MCA)	16	6.6	

LIST OF SCHEDULES

1.13 Water Source Heat Pump Schedule (cont'd)

Tag	U-486-HP	U-487-HP	U-488-HP
Service	Heating Glycol	Heating Glycol	Heating Glycol
Type	Water to Water	Water to Water	Water to Water
Location	Mechanical Mezz.	Mechanical Mezz.	Mechanical Mezz.
Manufacture	Ice Kube	Ice Kube	Ice Kube
Model	IKS144	IKS090	IKS060
Unit Dimensions – HxWxD mm (inches)	99 x 692 x 692 25.5 x 27.25 x 27.25	99 x 692 x 692 25.5 x 27.25 x 27.25	99 x 692 x 692 25.5 x 27.25 x 27.25
Source Side Data			
Fluid Flow – L/s (gpm)	2.20 (35)	1.26 (20)	0.95 (15)
Pressure Drop – kPa (ft)	84 (28)	84 (28)	84 (28)
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Load Side Data			
Fluid Flow – L/s (gpm)	1.70 (35)	1.26 (20)	0.95 (15)
Pressure Drop – kPa (ft)	84 (28)	84 (28)	84 (28)
Fluid	30% Ethylene Glycol	30% Ethylene Glycol	30% Ethylene Glycol
Source Side Heating Data			
Heat Absorption – kW (MBH)			
EST - °C (°F)	0 (32)	0 (32)	0 (32)
LST - °C (°F)	-2.9 (26.7)	-2.9 (26.7)	-2.9 (26.7)
Load Side Heating Data			
Heating Capacity–kW (MBH)	31.5 (100.9)	20 (68.2)	13.75 (46.9)
Electrical Power Draw – kW	8.18	4.93	3.47
COP	3.62	4.05	3.97
ELT - °C (°F)	40 (104)	40 (104)	40 (104)
LLT - °C (°F)	43.3 (110)	43.3 (110)	43.3 (110)
Source Side Cooling Data			
Heat Rejection – kW (MBH)			
EST - °C (°F)			
LST - °C (°F)			
Load Side Cooling Data			
Cooling Capacity – kW (MBH)			
Electrical Power Draw – kW			
EER			
ELT - °C (°F)			
LLT - °C (°F)			
Power Supply (V/Ph/Hz)	575/3/60	575/3/60	575/3/60

LIST OF SCHEDULES

Minimum Circuit Ampacity (MCA)	16	11	6.6

1.14 Gravity Relief Air Hood Schedule

Tag	GH-1	GH-2
Service	Exhaust (Electrical Room)	Exhaust (UV Process)
Volume – l/s (cfm)	6130 (13000)	2590 (5500)
E.S.P. Press – Pa (in wg)	40 (.16)	40 (.16)
Throat Size – mm (in)	750x1500 (30x60)	600x900 (24x36)
Throat Area – m^2 (ft^2)	1.16 (12.50)	0.56 (6.00)
Curb Cap – mm (in)	950x1700 (38x68)	800x1100 (32x44)
Hood Dimensions		
Width – mm (in)	1250 (50)	900 (36)
Length – mm (in)	1800 (72)	1200 (48)
Height – mm (in)	475 (19)	475 (19)
Manufacturer	Greenheck	Greenheck
Model No.	Fabra Hood	Fabra Hood
Options	1, 2, 3, 4	1, 2, 3, 4

Finishes:

1. Back draft dampers
2. Roof curb
3. Aluminum insect screen
4. Fibreglass hood insulation

LIST OF SCHEDULES

1.15 Boiler Schedule

Tag	U-475-EB-1
Manufacturer	Allied Boilers SUPER HOT
Model	BT-18
Heating Input ***(MBH)****(KW)*	61.4 (18)
Rated Heating Output ***(MBH)****(KW)*	61.4 (18)
Actual Heating Output (derated for elevation) ***(MBH)****(KW)*	61.4 (18)
Operating Pressure ***(psi)****(kPa)*	60 / 413
EWT ***(°F)****(°C)*	90 (32.2)
LWT ***(°F)****(°C)*	100 (37.8)
Flow Rate ***(gpm)****(L/S)*	20 (1.26)
Heat Transfer Surface ***(sq ft)****(m^2)*	
Electrical (V/ph/Hz)	600/3/60
Remarks	3 x 6 kW (18 kW Total)

END OF SECTION

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DIVISION 16

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DIVISION 16

Reviewed and Approved

Date

ELECTRICAL GENERAL REQUIREMENTS

1. GENERAL

1.1 Work Included

.1 Complete and operational electrical system as required by the Drawings and as herein specified.

1.2 Related Work

.1	General Requirements:	Division 1
.2	Site Work:	Division 2
.3	Concrete:	Division 3
.4	Process:	Division 11
.5	Mechanical:	Division 15

1.3 Drawings and Specifications

.1 The General Conditions, Supplementary Conditions, and Division 1 are a part of this Specification and shall apply to this Division.

.2 The intent of the Drawings and Specifications is to include all labour, Products, and services necessary for complete Work, tested and ready for operation.

.3 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation and grouping of devices.

.4 These Specifications and the Drawings and Specifications of all other divisions shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.

.5 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.

.6 If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting Bid.

.7 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.

1.4 Quality Assurances

.1 Codes, Rules, Permits & 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 Canadian Electrical Code (CEC), Canadian Standards Association (CSA) Standard C22.1 and the applicable building codes. Do overhead lines in accordance with CAN/CSA – C22.3 No.1 and underground systems in accordance with CAN/CSA – C22.3 No.7 except where specified otherwise.

.3 Quality of Work specified and/or shown on the Drawings shall not be reduced by the foregoing requirements.

.4 Immediately after award of Contract and prior to installation, verify location, arrangement and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render this Division responsible for any corrections necessary without additional compensation.

.5 Give all required notices, submit Drawings, obtain all permits, licences and certificates and pay all fees required for this Work.

.6 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

.2 Standard of Workmanship:

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

.2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.

.3 Arrange and install Products to fit properly into designated building spaces.

.4 Unless otherwise specified or shown, install Products in accordance with recommendations and ratings of Manufacturers.

1.5 Submittals

.1 Within 30 days of award of Contract, the Contractor shall submit a completed equipment procurement schedule which lists the Manufacturer and model of equipment, indicating the projected ordering, Shop Drawing submittal date and delivery dates of all Products to meet the required construction schedule.

.2 Submit samples as required where specified in Division 16.

.3 Prior to delivery of any Products to job Site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings for review as specified in Division 1. Submit Shop Drawings for all equipment as required in each Section of this Specification.

.4 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.

.5 The term "Shop Drawing" means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work.

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. Indicate cross references to Design Drawings and Specifications.

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.

.6 Manufacture of Products shall conform to revised Shop Drawings.

.7 Keep one (1) complete set of Shop Drawings at job Site during construction.

1.6 Record Drawings

.1 The Contractor shall keep one (1) complete set of white prints at the Site office, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of Record Drawings. As the Work on-site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions, which deviate from the original Contract Documents. Record Drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.

.2 Prior to substantial performance, the Contractor shall obtain CAD files of all electrical Drawings, using AutoCAD Release 2000i, and use the services of a competent CAD operator to transfer all as-built information, including: Addenda, Change Orders, Clarifications, Revisions, Site Instructions and Shop Drawings. Upon completion, the Contractor shall certify, in writing, that the As-built Record Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.

.3 On completion of the Work, two (2) weeks prior to final inspection, submit Record Drawings to Contract Administrator for review.

.4 Within one (1) month after return of Record Drawings by the Contract Administrator, obtain and pay for a complete set of original reproducible sepias. Transfer all changes from Record

Drawings to electronic Drawings (AutoCAD) and certify accuracy. Deliver electronic Drawings to the Contract Administrator.

1.7 Operation and Maintenance Manuals

.1 All maintenance manual data shall be submitted in an electronic format in accordance with the requirements of Division 1.

.2 Within thirty (30) days prior to substantial performance, the Contractor shall submit a draft copy of the proposed contents of each maintenance manual to the Contract Administrator for review. Once the draft copy is approved, the Contractor will supply four (4) copies in electronic format in accordance with the requirements of Division 1 Final copies of manuals to be received by Contract Administrator not less than seven (7) days prior to substantial performance.

.3 Each section of the manual shall contain the following information:

.1 Systems Descriptions. A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.2 Descriptive and technical data.

.3 Maintenance and operating instructions for all electrical equipment and controls. (These operating instructions need not be Manufacturer's data but may be typewritten instructions in simple language to guide the City of Winnipeg (City) in the proper operation and maintenance of his installation.)

.4 Lubricating and servicing intervals recommended.

.5 A copy of all wiring diagrams complete with wire coding.

.6 List of spare parts of all electrical equipment complete with names and addresses of sales, service representatives and suppliers.

.7 Copy of test data.

.8 A motor list showing each motor number, name, horsepower, full load amps, overload settings, nameplate, current rating, heater size and type, and current being drawn, on the form specified in Section 16970.

.9 Include type and accuracy of instruments used to obtain test data.

.10 Copy of final inspection certificate.

.11 Copy of the purchase order, showing equipment make and model numbers issued to the Manufacturer complete with all addenda. All cost details may be hidden.

.12 Copy of all warranty certificates.

.13 Set of final reviewed Shop Drawings.

.14 Names, addresses, phone numbers and facsimile numbers of Contractor, Contract Administrators, sub-contractors and suppliers used on the Work together with a Specification reference of the portion of the Work they undertook.

1.8 Product Handling

.1 Use all means necessary to protect the Products of this Division before, during and after installation and to protect Products and installed Work of all other trades.

.2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.

.3 Remove advertising labels from all electrical equipment. Do not remove identification of certification labels.

.4 Remove dirt, rubbish, grease, etc. resulting from this Work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

1.9 Alternate and Separate Prices

.1 In accordance with the Instructions to Bidders, state on the Bid Form in the space provided, the amount to be added or deleted from the base bid tender amount for the use and installation of equipment as an alternate to those specified.

1.10 Guarantee

.1 Furnish a written guarantee to the City prior to final contract payment, which will be in effect for one (1) year from the date of final acceptance of the complete Work. Replace or repair at no cost to the City any defective material or workmanship except where, in the opinion of the Contract Administrator, such defects are due to the misuse or neglect by the City.

.2 This general guarantee shall not act as a waiver of any specified or special equipment guarantees, which cover a greater length of time.

1.11 Progress Claims

.1 Within thirty (30) days after award of Contract, a breakdown of material and equipment items including labour and expense components shall be compiled on the consultant format. Subsequent request for payment shall be documented accordingly.

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 throughout the project.

.2 Products and materials referred to in the Specifications by trade names, Manufacturer's name and catalogue reference are those, which shall be used as the basis for the Bid.

.3 The design has been based on the use of the specified Product.

2.2 Quality of Products

.1 All Products provided shall be CSA Approved, Canadian Underwriters' Laboratory (UL) approved where applicable, and new, unless otherwise specified.

.2 If Products specified are not CSA approved, obtain special approval from the local regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

.3 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.3 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specifications, uniformity of manufacture shall be maintained for similar Products throughout the Work.

2.4 Product Finishes

.1 Finish all cabinets, panelboards, switchboards, equipment cabinets, cable trays, etc. in American National Standards Institute (ANSI) 61 grey enamel unless otherwise specified.

.2 Apply primer on all items, which are to be finished on the job.

.3 Touch up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

2.5 Use of Products during Construction

.1 Any equipment used for temporary or construction purposes shall be approved by the Construction Manager and in accordance with the General Conditions, "Use of Premises." Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The warranty period shall not begin until the date of Substantial Performance of the Work.

2.6 Non-Specific Date/Time Compliance

.1 All equipment, hardware, software and firmware (for the purposes of this clause, the "Product") delivered or deliverables resulting from any services provided are fully Date Compliant and the Product will not adversely or materially effect the daily business operations as a result of a date related computer problem (for the purposes of this clause #, the "Warranty"). Date Compliant means that the Product accurately and correctly processes and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording and sequencing operations) including year, century and leap year calculations.

.2 Provide documentary proof of Date Compliance prior to substantial completion listing all equipment and certifying their compliance.

.3 Notwithstanding any other remedy available under this agreement or at law for breach of the Warranty, any Product that is not Date Compliant shall, within 24 hours of receipt of notice of the breach, be repaired or replaced at the Contractor's sole cost and expense, including parts, labour, transportation and insurance, so as to correct any failure to meet the Warranty.

3. EXECUTION

3.1 Site Examination

.1 Examine the Site of Work and become familiar with all features and characteristics affecting this Work before submitting Bid.

.2 No additional compensation will be given for extra Work due to existing conditions which such examination should have disclosed.

.3 Report to the Contract Administrator any unsatisfactory conditions which may adversely affect the proper completion of this Work.

3.2 Location of Outlets and Luminaires

.1 Electrical Drawings are, unless otherwise indicated, drawn to scale and approximate distances and dimensions may be obtained by scaling. Figured dimensions shall govern over scaled dimensions. Where exact dimensions and details are required, refer to Architectural and Structural Drawings.

.2 Outlet and equipment locations shown on the Drawings are approximate. Locations may be revised up to 3 m to suit construction and equipment arrangements without additional cost to the City, provided that the Contractor is notified prior to the installation of the outlets, or equipment.

.3 Maintain luminaire locations wherever possible. Notify the Contract Administrator of conflicts with other services.

.4 Unless otherwise specified or shown, install Products in accordance with recommendations and ratings of Manufacturers.

3.3 Separation of Services

.1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.

.2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings shall not be used for the support of wiring.

3.4 Equipment Identification

.1 3 mm thick plastic lamicoid name plates, black face, white core, mechanically attached with self tapping screws, to be attached to the front face of the following equipment:

NAMEPLATE SIZES

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.1 Distribution Centres (indicate designation, bus capacity, voltage)

.2 MCCs (designation, voltage)

.3 Starters, contactors, disconnects (designation, voltage, load controlled)

.4 Panelboard (designation, voltage, bus capacity)

.5 Automatic transfer switch (designation, voltage, rating)

.6 Terminal cabinets and pull boxes (system, voltage)

.7 Transformers (designation, capacity, primary and secondary voltage)

.2 Color code exposed conduits (including conduits above T-bar ceilings), junction and pull boxes, and metallic sheathed cables with paint or plastic tape (25 mm wide band) at 15 m intervals. Color coding to be as follows:

SYSTEM	MAJOR BAND	MAJOR BAND
High Voltage	Yellow	Purple
347/600 V Normal	Dk. Blue	
120/208 V Normal	Lt. Blue	
UPS System	Lt. Blue	White
Fire Alarm System	Red	
Communication Circuits	Black	Yellow

.3 Provide neatly typed circuit directories in panelboards to indicate the area or equipment controlled by each branch circuit.

.4 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.

Conductors:

Equipment Grounding – Green
Neutral Conductor – White

347/600 Volt System	277/480 Volt System
Phase A – Orange	Phase A - Orange/Black
Phase B – Brown	Phase B – Blue/Black
Phase C – Yellow	Phase C - Black/White

120/208 Volt System
Phase A – Red
Phase B – Black
Phase C – Blue

3.5 Wiring to Equipment Supplied by Others

.1 Equipment supplied by the City or under other Divisions will be moved to the installation Site by others. However, the electrical connection to the equipment shall be done by this Division.

3.6 Testing

.1 Refer to Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.7 Single Line Diagram

.1 Provide and mount a framed as-built single line diagram to be located adjacent to the main electrical equipment. Use a clear plexiglass cover. The diagram shall be 914 mm x 600 mm minimum, with all lettering Leroyed.

3.8 Instructions to City's Personnel

.1 Refer to Section 16990 - Electrical Equipment and Systems Demonstration and Instruction.

3.9 Access Panels

.1 Where electrical equipment, junction boxes, remote ballasts or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical Work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Contract Administrator.

.2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Contract Administrator.

3.10 Mounting Heights

.1 Unless a conflict exists, use the following as mounting heights from finished floors to centre of device.

Thermostats	1,400 mm
Panelboards, starters, and disconnects (to top of cover)	2,000 mm
End of line resistors	1,800 mm
Receptacles	1,400 mm
Light Switches	1,400 mm
Fire Alarm Manual Stations	1,400 mm
Fire Alarm Bells	2,100 mm
Telephone outlet	1,400 mm

3.11 Sealing of Wall and Floor Openings

.1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.

.2 Openings shall be sealed when all wiring entries shown on the Drawings have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds, which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.12 Housekeeping Pads

.1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads that, unless otherwise noted, shall be the responsibility of the Contractor.

.2 The Contractor shall determine the extent of the housekeeping pads required and supply all information and details as to size and locations to the Contract Administrator within thirty (30) days after the award of Contract.

3.13 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For wall, partitions and ceilings the ends shall be flush with the finish on both sides but for floors they shall extend 100 mm above finished floor level.

.3 The space between the sleeve and the conduit shall be filled with Dow Corning silicone room temperature vulcanizing (RTV) foam for fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate and position sleeves exactly prior to construction of walls, floors.

.5 Failure to comply with the above requirements shall be remedied at this Division's expense.

3.14 Temporary Lighting and Power

.1 Provide grounded extension cords and temporary lights as required for electrical Work.

.2 Coordinate with General Contractor for obtaining temporary power service.

.3 If City’s operations will be affected by any power outage required for this Work, give adequate notice to the City and do not interrupt power until approval has been obtained.

.4 Give adequate notice to Contractor of any power outage required for this Work. Schedule outages to provide least interference with other Work.

3.15 Insulation Resistance Testing

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of the Contract Administrator.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

.6 Submit test results for the Contract Administrator’s review.

3.16 Load Balance

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance. Adjust branch circuit connections as required to obtain best balance of current between phases and record changes (maximum deviation of 15%).

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Submit, at completion of Work, report listing phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load. State hour and date on which each load was measured, and voltage at time of test.

END OF SECTION

SCOPE OF ELECTRICAL WORK

1. GENERAL

.1 Supply and Install all material, equipment, wiring and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Canadian Electrical Code (CEC).

2. WORK INCLUDED

2.1 Related Work

.1 The Administrative Sections under Division 0 (Bidding and Contract Requirements) and 1 (General Requirements) shall be considered to be part of these Specifications.

2.2 General Requirements

.1 General Clean-up.

.2 All inspection and obtaining all permits, licenses required by various Inspection Agencies and local regulations related to Electrical Trade.

.3 Scaffolding.

.4 Shop Drawings.

.5 Project Record Documents (As-built Drawings) where specified.

.6 Operating and Maintenance (O&M) Data, where specified.

2.3 Specific Requirements Included But Not Limited to Scope of Work

.1 Provide pole mounted 66 kV load break switch pole adjacent to Manitoba Hydro service pole. Provide an additional pole for 66 kV fuses, lightning arrestors and dip to under ground services cable to 5 MVA transformer.

.2 Provide 66 kV direct buried cable from dip pole to 5 MVA transformer.

.3 Provide a 5 MVA oil filled pad mounted transformer to operate as the primary service to the UV Building. Include secondary connections at secondary terminals of transformer. The transformer shall have a primary of 66 kV and a secondary of 4.16 kV. The secondary voltage of the new transformer shall be tap-setting to the same voltage as the existing North End Water Pollution Control Centre (NEWPCC) secondary voltages at the existing plant Main Distribution in the Grit Building.

SCOPE OF ELECTRICAL WORK

.4 Provide a Step-and-Touch ground grid at the 5 MVA transformer as indicated in CEC Table 52, Institute of Electrical and Electronic Engineers (IEEE) Standard 80 and specified herein.

.5 Provide 66 kV primary cables to the 5 MVA pad mounted transformer and properly terminate. Provide 4.16 kV secondary cables from secondary of pad mounted transformer to 5 kV distribution in UV Building Electrical Room. Refer to Drawings for detail and location.

.6 Provide a new 5 kV breaker and Install at the north end of the existing distribution located in the existing Grit Building Electrical Room. New breaker shall be connected, by matching bus, to the existing 5 kV distribution equipment. New 5 kV breaker cubical shall be suitable to accept an additional 5 kV breaker (total of two (2) breakers with one (1) unit being a space for an additional breaker unit).

.7 All 4.16 kV cable, install underground, will be in direct buried duct banks as detailed on the Drawings. The 4.16 kV cables from the power transformer and Manhole #2 to the UV Building shall be installed in concrete encased duct banks. Refer to Drawings for duct bank details.

.8 Provide new cables from new 5 kV breaker in Grit Building distribution to UV Building distribution via existing cable tray, existing concrete duct bank, direct buried duct bank and manholes and new concrete encased duct bank to UV Building 5 kV distribution as indicated on Drawings.

.9 Provide new 5 kV distribution and Install in the electrical room of the new UV Building. Refer to Specifications and Drawings for complete supply and installation of this equipment.

.10 Provide dry type transformers for UV equipment. These transformers (2-4 MVA) will have a primary winding of 4.16 kV and secondary winding of 277/480 volt, 3Ø, 4 wire. Transformers shall be suitable for installation outdoor (Canadian Standards Association (CSA) 3) and be K13 rated. Refer to Drawings and Specifications for additional details.

.11 Provide dry type transformers for pumps and building equipment. These transformers (2-1.25MVA) will have a primary winding of 4.16kV and secondary winding of 600 volt, 3Ø, wire. Transformers shall be suitable for installation outdoor (CSA 3). Refer to Drawings and Specifications for additional details.

.12 Provide a 277/480 volt, 3Ø, 4 wire distribution to service the UV equipment. This distribution will be connected to the secondary of the 4 MVA transformers and service all the UV equipment. The 277/480 volt distribution will consist of draw-out breakers sized as indicated on the Drawings and herein specified.

SCOPE OF ELECTRICAL WORK

.13 Provide a 600 volt, 3Ø, 3 wire distribution to service the lift station pump motors and the building equipment. This distribution shall be connected to the secondary of the 1.25 MVA transformers. The 600 volt distribution will consist of draw-out breakers sized as indicated on the Drawing and herein specified.

.14 Provide a dry type transformers for building and associated UV equipment. Transformers will be 75 kVA with primary winding of 600 volt and secondary windings of 120/208 volt, 3Ø, 4 wire. A 120/208 volt, 3Ø, 4 wire panel board will be connected to this transformers to provide the control power supply and general building power.

.15 Provide all cables and wiring to complete the entire UV installation in coordination with the supply of this equipments. UV equipment and Specification to provided to the City by Trojan Technologies Inc.

.16 The secondary service from all of the dry type transformers will be connected to the specific distributions with bus duct or cable as indicated in this Specification and on the Drawings.

.17 Install variable frequency drive (VFD) units for each of the lift station pumps. Install harmonic filters for each of the VFD units as indicated in on the Drawings or as required. VFD units and Harmonic filters, for the lift station pumps, will be supplied to the Contractor by the City.

.18 Provide a weatherproof disconnect and control termination above ground at each lift pump location to allow the pump cable to be disconnected from the pump feeder to provide a method of removing the pump and pump cables to allow replacement for pump.

.19 Provide all lighting, lighting controls and general power as specified herein and indicated on the Drawings.

.20 Provide welding outlets, to accommodate portable welders, as indicated on the Drawings and herein specified. New outlets shall be suitable to match existing plant welders.

.21 Provide electrical services to the mechanical equipment as specified in Divisions 15 and 16 and as indicated on Drawings.

.22 Provide disconnect switches of molder case switches for mechanical equipment and UV equipment as may be required. Refer to Motor Schedule and Drawings for addition information.

.23 Provide all cabling required to make a complete and operational facility. Provide a raceway system to allow complete installation of all cabling. Refer to Cable Schedule and Raceway Schedule in Specification.

.24 Provide a complete Fire Alarm System as specified herein and indicated on the Drawings. System shall be connected to the Main Administration Building Server Room. Provide copper wire inter connection with the capability of up grading to fibre cable. Final connection to be determined on site. Install fibre cable adapters in Fire Alarm Panel.

.25 Provide a Security System consisting of door switches and motion detectors. Signal from these devices to be terminated in the UV-CP1 Control Panel and be extended to Administration Building Server Room. Final connection location to be determined on site.

.26 Provide a CCTV System complete with cameras, transmission coax cable and power supplies as require for a complete system. Camera coax cables shall be terminated in the UV-CP1 Control Panel and extended to the Administration Building Server Room. Final connection in Server Room to be determined on-site.

.27 Refer to Division 17 and provide all wiring associated with control devices as indicated in this Specification and indicated on the Drawings.

.28 Provide complete primary and secondary grounding as herein specified and indicated on the Drawings. New ground shall be connected to existing ground system in the existing Grit Building main Electrical Room. All ground shall comply with the CEC and local amendments to this code.

.29 Reinstall existing roadway light standards and connect to existing light standard circuits. Provide trenching to accommodate new light standard wiring. Provide grounding as required.

2.4 Demolition

.1 Remove existing roadway lighting standards as indicated on the Drawings.

.2 Remove existing roadway lighting wiring between light standards being removed.

2.5 Additional Requirements

.1 Provision of all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks and written system verification reports to provide a complete system that is ready for commissioning and startup (refer also to Section 16980).

.2 Provision of commissioning and startup of all systems included in the Scope of Work.

2.6 Materials

.1 Bus systems including all forms of buses integral with the electrical power system, together with their associated insulation, supports, bus ducts and protective devices.

.2 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.

.3 Cables and bus support systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways and all forms of rigid, flexible, metallic and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date, or buried conduit for wiring work by others, only when such buried conduit is indicated in the Contract Documents.

.4 Control panels (excluding the UV Disinfection System Control Panel (SCC)) associated with any electrical equipment covered under this Section of Work.

.5 Circuit breakers of all types and for all applications associated with electrical equipment, which receives its power supply from the main, auxiliary or emergency (including battery) system.

.6 Grounding systems, as required by the Electrical Code, or as otherwise specified in the bid documents.

.7 Control and instrumentation systems - electrical or electronic including high frequency, ultra high frequency and microwave control and instrumentation systems, with auxiliary equipment and components, unless specified otherwise.

.8 Transformers of various types, dry, encapsulated etc., and for all applications, except control transformers supplied with Mechanical Equipment included in Division 15.

.9 Electronic data processing and transmission systems, including auxiliary equipment, interface and components.

3. WORK EXCLUDED

3.1 Specific Exclusions

.1 Supply of UV Disinfection System Control Panel (SCC) as indicated in Contract 1 (Supply of UV Equipment).

.2 Supply of Water Level Sensors supplied with UV equipment.

.3 Supply of VFDs for UV Influent Pumps

3.2 Other Work Excluded

.1 Special starters, including multi-speed switches, which are associated with packaged units not detailed in the Electrical Specifications.

.2 Perforations through roofing materials for electrical servicing or attachments (Division 7).

.3 Painting (on-site), except touch-up of electrical equipment (Division 9).

.4 Ducted fans (Division 15).

.5 Ducted heaters (Division 15).

.6 Pneumatic tube systems (Division 15).

.7 Control transformers supplied with Mechanical Equipment (Division 15).

.8 All control wiring between equipment supplied by Division 15 HVAC system will be performed by Division 17.

4. UNITS OF MEASUREMENT

4.1 General

.1 The Contract Documents have been prepared using the modified International System (SI) units of metric measurement. Whenever appropriate, available metric Products shall be used unless otherwise specified herein.

.2 Only metres (m) and millimetres (mm) are used. Generally, metres are used for measurements of 10 m or more, and millimetres for measurements less than 10 m.

.3 All measurements on Drawings are in millimetres unless otherwise indicated.

4.2 Conversions

.1 The following three (3) conversion methods were used in Product and location dimensions:

.1 Hard Conversion: Industry available Products which are manufactured in metric measurements.

.2 Soft Conversion: Products which are still manufactured in Imperial units and are converted in Specifications using arithmetic conversion factors.

.3 Rationalized Conversion: Dimensions which are soft converted and rounded off for ease of measurements.

.2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.

5. DEFINITIONS

5.1 General

.1 All terminologies, abbreviations and acronyms used in this document are as listed in the various Standards, Codes, Rules and Bulletins used herein.

6. FORMAT

6.1 Practice

.1 This Scope of Work has been written to conform to the Manitoba Construction Association (MCA) Bid Depository Rules and Procedures and Scope of Work.

6.2 Sections

.1 The Sections are written in a three (3) part format: General, Products and Execution.

6.3 Reference

.1 Imperative tense has been used throughout this Document for Work intended for the successful Contractor. There shall be no Work exclusions unless they have been clearly identified as such herein.

.2 Any reference to "Design Authority" shall mean Earth Tech (Canada) Inc., Consulting Engineers.

.3 The word "provide" shall mean "supply and install" unless otherwise indicated.

7. CODES

7.1 General

.1 All Codes, Standards, Rules, Regulations, Bulletins, By-laws etc., shall be those that are currently enforced in the locality of job Site, unless otherwise specified herein.

END OF SECTION

CONCRETE ENCASED DUCT BANKS AND MANHOLES

1. GENERAL

1.1 Related Work

.1 Excavating, Trenching and Backfilling: Division 2

.2 Concrete Form-Work: Division 3

.3 Concrete Reinforcement: Division 3

.4 Cast-In-Place Concrete: Division 3

.5 Brick Masonry: Division 4

.6 Mortar and Grout for Masonry: Division 4

1.2 Shop Drawings

.1 Submit Shop Drawings for precast manholes in accordance with Division 1 submittals.

2. PRODUCTS

2.1 PVC Ducts

.1 Polyvinvyl chloride (PVC) ducts, encased in reinforced concrete.

2.2 PVC Duct Fittings

.1 Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to making complete installation.

.2 Expansion joints.

.3 Rigid PVC 5° angle couplings.

2.3 Pre-Cast Concrete Manholes

.1 Precast concrete manholes and auxiliary sections fabricated in steel forms.

.2 Aggregates: to Canadian Standards Association (CAN) 3-A23.1.

.3 Cement: to CAN3-A5, Type 10

.4 Steel welded wire fabric mesh reinforcing: to CSA G30.3, CSA G30.5. Openings and critical areas trimmed with steel reinforcing bars: to CSA G30.12.

.5 Pulling inserts and bolts for racks integrally cast in concrete: to American National Standards Institute/American Concrete Institute (ANSI/ACI)-347-78.

.6 Neoprene gasket seals between manhole sections: to American Society for Testing and Materials (ASTM) D1056-85.

2.4 Manhole Necks

.1 Concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.

.2 Build up neck with concrete brick and mortar to achieve above if necessary.

2.5 Manhole Frames and Covers

.1 Cast iron manhole frames and covers.

.2 Bolted on covers to prevent unauthorized entry.

2.6 Grounding

.1 Ground rods: to Section 16160 - Primary Grounding for cable rack grounding.

2.7 Cable Racks

.1 Hot dipped galvanized cable racks and supports.

.2 12 x 100 mm preset inserts for rack mounting.

2.8 Cable Pulling Equipment

.1 6 mm stranded nylon pull rope tensile strength 5 kN continuous throughout each duct run with 3 m spare rope at each end.

2.9 Markers

.1 Concrete type cable markers: 600 x 600 x 100 mm, with words; “cable”, “joint” or “conduit” impressed in top surface, with arrows to indicate change in direction of duct runs.

3. EXECUTION

3.1 Installation General

.1 Install underground duct banks and manholes including formwork.

.2 Build duct bank and manholes on undisturbed soil or on well compacted granular fill not less that 150 mm thick, compacted to 95% or maximum proctor dry density.

.3 Open trench completely between manholes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.

.4 Prior to laying ducts, construct “mud slab” not less than 75 mm thick.

.5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.

.6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.

.7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level or as specified on Drawings.

.8 Make transpositions, offsets and changes in direction using 5º bend sections. Do not exceed a total of 20º with duct offset.

.9 Use bell ends at duct terminations in manholes or buildings.

.10 Use conduit to duct adapters when connecting to conduits.

.11 Terminate duct runs with duct coupling set flush with the end of concrete envelope when dead ending duct bank for future extension.

.12 Cut, ream, and taper end of ducts in field in accordance with Manufacturers’ recommendations, so that duct ends are fully equal to factory-made ends.

.13 Allow concrete to attain 50% of its specified strength before backfilling.

.14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.

.15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

.16 Immediately after placing of concrete, pull through each duct a wooden mandrel not less than 300 mm long and of a diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.

.17 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.

3.2 Manholes

.1 Build cast-in-place manholes.

.2 Install precast manholes.

.3 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift. Provide key in walls to slab. Place 100 x 6 mm PVC water bar vertically in key. Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make manhole to duct connection as indicated.

.4 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four (4) 10 m steel dowels at each duct run connection to anchor duct run.

.5 Alternately connect large duct runs by leaving a square opening in wall, later pouring duct run and wall opening in one pour, and install 10 m x 3 m reinforcing rods in duct run at manhole connection.

.6 Install manhole frames and covers for each manhole. Set frames in concrete grout onto the manhole neck.

.7 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.

.8 Install cable racks, anchor bolts and pulling irons as indicated.

.9 Grout frames of manholes. Cement grout to consist of two parts sand and one part cement and sufficient water to form plastic slurry.

.10 Ensure filling of voids in joint being sealed. Plaster with cement grout, walls, ceiling and neck.

.11 Spray paint an “X” on ceiling of manhole above floor drain or sump pit.

3.3 Markers

.1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.

.2 Mark ducts every 150 m along straight runs and changes in direction.

.3 Where markers are removed to permit installation of additional duct, reinstall existing markers.

.4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.

.5 Provide Drawings showing locations of markers.

3.4 Inspections

.1 Advise Contract Administrator so that he may inspect ducts prior to placing and be present during placement of concrete and clean-out.

END OF SECTION

INSTALLATION OF CABLES INTRENCHES AND IN DUCTS

1. GENERAL

1.1 Related Work

.1 Excavation and Backfilling: Division 2

2. PRODUCTS

2.1 Cable Protection

.1 Provide 600 x 600 x 50 concrete patio blocks above directed buried duct banks. Patio blocks to be colored RED for identification.

2.2 Markers

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

3. EXECUTION

3.1 Direct Burial of Cables

.1 After sand bed specified in Division 2 is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.

.1 Make splices and terminations in accordance with Manufacturer's instructions using approved splicing kits.

.4 Underground cable splices not acceptable.

.5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with Manufacturer's instructions.

.6 Maintain 75 mm minimum separation between cables of different circuits. Maintain 300 mm horizontal separation between low and high voltage cables. When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position. At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables. Maintain 300 mm minimum lateral and vertical separation for fire alarm and control, cables when crossing other cables, with fire alarm and control cables in upper position. Install treated planks on lower cables 0.6 m in each direction at crossings.

.7 After sand protective cover specified in Division 2 is in place, install continuous row of concrete patio as indicated to cover length of run.

3.2 Cable Installation in Ducts

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use Canadian Standards Association (CSA) approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

.6 Before pulling cable into ducts and until cables properly terminated, seal ends of lead covered cable with wiping solder; seal ends of non-leaded cables with moisture seal tape.

.7 After installation of cables, seal duct ends with duct sealing compound.

3.3 Markers

.1 Mark cable every 150 m along cable or duct runs and changes in direction.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

.3 Install concrete patio type markers.

.4 Lay concrete markers flat and centered over cable with top flush with finish grade.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform tests using qualified personnel. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test.

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 5000V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 High Potential (Hipot) Testing.

.1 Conduct Hipot testing at 200% of original factory test voltage in accordance with Manufacturer’s or IPCEA recommendations.

.4 Leakage Current Testing.

.1 Raise voltage in steps from zero to maximum values as specified by Insulated Power Cable Engineers Association (IPCEA) Manufacturer for type of cable being tested.

.2 Hold maximum voltage for specified time period by IPCEA or Manufacturer.

.3 Record leakage current at each step.

.5 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested and result of each test.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

DIRECT BURIED UNDERGROUND CABLE DUCTS

1. GENERAL

1.1 Work Included

.1 Provide complete system of underground ducts, fittings and turn-ups for the installation indicated on the Drawings.

1.2 Related Work

.1 Excavation and backfilling: Division 2

.2 Concrete Work: Division 3

.3 Plumbing and Drainage: Division 3

2. PRODUCTS

2.1 Rigid P.V.C. Duct

.1 Duct: Rigid non-metallic conduit of unplasticized polyvinyl chloride type EB-1 requiring concrete encasement, type DB-2 heavier wall for direct burial without concrete encasement, conforming to Canadian Standards Association (CSA) Standard B196.1, manufactured by Canron Plastics Ltd. Nominal length 6 m plus or minus 12 mm with minimum wall thickness at any point of 3.0 mm.

.2 Accessories: Bell ends, couplings, reducers, plugs, caps, adaptors, bends and other fittings of same materials as duct. Use solvent weld compound as recommended by Manufacturer. Horizontal, vertical and foundation spacers as manufactured by Pilgrim Products Ltd.

.3 Expansion Joints every 100 m and as required.

2.2 Cable Pulling Equipment

.1 6 mm stranded nylon pull rope tensile strength 5 kN.

2.3 Duct Spacers

.1 Plastic spacers to suit installation shown, manufactured by Pilgrim Products Ltd.

2.4 Markers

.1 Concrete type cable markers: As indicated, with words; “cable’, “joint’ or “conduit” impressed in top surface, with arrows to indicate change in direction of duct runs.

3. EXECUTION

.1 Install underground ducts for wiring systems as shown on the Drawings and as per Manufacturer's instructions.

.2 Clean inside of duct before laying.

.3 Provide a separate green insulated copper ground wire in all ducts, even if not shown. Use Canadian Electrical Code (CEC) to size ground wire.

.4 Furnish minimum of 85% of total footage of each size in standard lengths of 6 m or 3 m. Remainder of each size may be furnished in random lengths, but not less than 1.5 m.

.5 Arrange ducts in horizontal layers separated by plastic spacers to provide horizontal and vertical spacing between duct centres, as shown on Drawings. Stack spacers vertically above each other and Install in at least two groups per 3 m length of duct.

.6 Support duct bank on plastic foundation spacers on same centre lines as tier separators. Foundation spacers to maintain at least 75 mm clearance between ducts and trench bottom or mud mat. Ensure full, even support every 1.5 m throughout duct length.

.7 Make joints with tapered couplings to provide a secure watertight connection. At locations where coupling is loosely fitted to produce a slight change of direction of the duct run, thoroughly waterproof joint with a coating of solvent compound. Stagger all joints to provide 200 mm vertical and horizontal clearance between adjacent couplings. Where needed, use bender to provide bends of radius required.

.8 Make bell and spigot joints. Drive ducts together as recommended by Manufacturer to produce a solid watertight connection. Stagger all joints to provide 200 m vertical and horizontal clearance between adjacent couplings. Where needed, use manufactured bends to provide bends of radius required.

.9 When all ducts are installed, brace whole assembly at each spacer group to prevent duct floating when concrete is placed.

.10 Use adaptors and connect duct to a 90 degree rigid, heavy-wall, steel conduit bend where conduit rises above ground.

.11 Terminate ducts with standard bell ends where ducts enter manholes, cable pits, junction boxes and building interiors.

.12 Pull through each duct wooden mandrel not less than 300 mm long and of diameter 6 mm less than the internal diameter of duct, following by stiff bristle brush to remove

sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling in cables.

.13 In each duct Install pull rope continuous throughout each duct run with 3 m spare rope at each end.

.14 Plug ends of unused spare ducts with plugs of same material as ducts.

.15 Seal all joints in ducts with solvent cement.

.16 Install marker as required.

.17 Ensure lines and levels for underground ducts are set to obtain proper drainage, coverage, separation, etc. Ensure such conditions are met prior to proceeding with the Work.

.18 Construct duct runs to provide at least 750 mm from top of concrete encasement to finished surface above. Grade duct runs between manholes, vaults, cable pits and buildings to ensure proper drainage. Minimum slope shall be 75 mm per 30 m. Provide grades and slopes shown on Drawings. Depths of cover shown on electrical Drawings are minimum; greater depths may result from grading of ducts.

.19 Install ducts in accordance with additional requirements of utility or service company having jurisdiction.

.20 For each duct run, Install a 2/0 bare copper ground wire in sand or earth fill below bottom of concrete. Connect to ladder rungs, cable supports and other manhole or vault accessories. Connect to main ground bus.

END OF SECTION

POLE LINES AND HARDWARE

1. GENERAL

1.1 Work Included

.1 Supply and Install all necessary products to make a complete system.

.2 This Specification covers standard overhead pole line construction for 66 kV, and also includes ancillary equipment.

.3 Supply and Install vertical mounted gang operated switch with operating handle on indicated pole. Provide Ground Grid Pad at base of pole under switch operator.

.4 Supply and Install fusing, lightning arrestors and equipment for cable dip service on fuse pole.

1.2 References

.1 Canadian Standards Association (CAN/CSA) C22.3 No. 1, Overhead Systems.

.2 Canadian Electricity Association (CEA) Purchasing Spec LWIWG-01, Dead-end/Suspension Composite Insulator for Overhead Distribution Lines.

.3 CEA Purchasing Specification LWIWG-02, Line Post Compose Insulator for Overhead Distribution Lines.

.4 CEA Purchasing Specification LWIWG-03, Line Post Insulator for Guy Wires.

.5 CEA Purchasing Specification WCWG-03, Bare Overhead Aluminum Conductors.

.6 CAN3-G12, Zinc-Coated Steel Wire Strand.

.7 CAN/CSA C83, Communication and Power Line Hardware.

.8 CAN/CSA O80 Series, Wood Preservation.

.9 CSA O15.2, The Physical Properties of Western Red Cedar Poles and Reinforcing Stubs.

.10 CSA O15.3, The Physical Properties of Jack, Lodgepole, and Red Pine Poles and Reinforcing Stubs.

.11 CSA O116, Power and Communication Sawn Wood Crossarms.

.12 Manitoba Hydro Standards.

1.3 Submittals

.1 Submit Shop Drawings in accordance with Specification Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Unacceptable Structures

.1 Trees, rock outcroppings, or buildings other than those which supply energy to or receive energy from a line are unacceptable structures.

2.2 Height

.1 Pole shall be of sufficient height and strength to accommodate all circuits for which they are intended according to CSA C22.3 No.1, Overhead Systems, and to maintain clearances under maximum sag and loading conditions between circuits and between the lowest conductor and ground, and to adjacent building structures.

2.3 Equipment Identification

.1 Rustproof marker attached with rustproof nails to mark each pole with 50 mm high designated number.

2.4 Treatment

.1 Poles shall have coatings and/or preservation treatment which:

.1 Are suitable for service conditions and planned service life of the structure.

.2 Do not cause corrosion of pole line hardware.

.2 The treatment of wood poles shall conform to the requirements of CAN/CSA 080.

.3 Wood poles for temporary lines need not be treated.

2.5 Setting Depth Mark

.1 Poles shall be marked in accordance with CSA 015.2, 015.3, or shall be provided with a setting gain 3.6 m (12’) from the butt to indicate the depth of setting.

2.6 Pole Selection

.1 Wood poles shall be Western Red Cedar, Lodgepole Pine or Red Pine with dimensions not less than those given in CSA 015.2 and 015.3 respectively.

.2 Wood poles used for primary lines shall be a minimum of Class Five (5) and at least 10.5 m (35') in length.

.3 Wood poles shall be of a class and length suitable for the service conditions and the design loads as defined in CAN/CSA C22.3 No. 1 or as dictated by specific local conditions.

2.7 Equipment Structures

.1 Poles, which support load-break disconnect switches or other equipment, shall be of a class as determined by a competent individual or agency based on the stability, strength, and climbability of the pole. Minimum strength shall be in accordance with CAN/CSA C22.3 No. 1.

.2 Vertically mounted primary load-break switch shall be mounted on a single pole.

.3 For primary reclosers two (2) double arms.

.4 For each crossarm:

.1 Insulator pins: to CSA O124.

.2 Two (2) – 3 x 6 mm galvanized steel braces.

.3 One (1) – 9 x 38 mm galvanized steel lag screw.

.4 Two (2) – 9 x 114 mm galvanized steel bolts.

.5 Through bolts and double arm bolts as required.

2.8 Insulators and Hardware

.1 General

.1 Insulators and hardware shall be:

.1 Of a type listed by the Manufacturer as being suitable for the application.

.2 Suitable for the local environmental conditions.

.2 Insulators

.1 Line suspension insulators shall be made of wet process porcelain or toughened glass to the requirements of CSA Standard CAN/CSA C411.1.

.2 Line pine and guy strain insulators shall be made of wet process porcelain or toughened glass to the requirements of American National Standards Institute (ANSI) Standards.

.3 Line post insulators shall be made of wet process porcelain to the requirements of ANSI Standards.

.4 Other types of insulators not included in CSA standards, shall meet the requirements of the appropriate ANSI or International Electrotechnical Commission (IEC) standards.

.5 Non-ceramic insulators shall be permitted when it has been demonstrated that they have electrical and mechanical strength and life expectancy suitable for the application.

.6 Line insulators shall have a wet flashover rating of at least:

.1 Three (3) times conductor-to-ground voltage for pin type insulators.

.2 Four (4) times conductor-to-ground voltage for suspension type insulators, regardless of whether they are in the suspension position or the vertical position.

.3 One point seven (1.7) times conductor-to-ground voltage for guy strain insulators.

.4 10,000 volts for secondary and neutral insulators.

.7 Two (2) or more insulators may be used in series to comply with Subrules 6.2 and 6.3.

.8 Subrules 6. and 7. shall not apply to transmission lines which have a coordinated insulation system designed to meet the service conditions and required reliability level.

.3 Hardware

.1 Hardware shall be of a strength and type suitable for the application, shall meet the requirements of CAN/CSA C83, and if of a ferrous material other than stainless steel shall be hot dip galvanized.

.4 Installation

.1 Insulators shall be secure and mounted in accordance with the insulator Manufacturer’s instructions.

.2 Hardware shall be tight and secure and locking washers or equivalent shall be installed where appropriate.

.3 Insulator and associated hardware installations shall be designed to minimize the possibility of power-arc follow-through causing damage to the line in the event of a line insulator flashover.

2.9 Guys and Anchors

.1 General

.1 A guy assembly shall be provided at each dead-end construction and at any pole where the line angle is greater than 5°, and shall be located as close as practicable to the centre of the load that the guy is intended to sustain.

.2 Notwithstanding Subrule 1. Poles which carry secondary lines or self-supporting communications lines only, when set in firm ground, need not necessarily be guyed except at line ends or where the line angle exceeds 25°.

.3 Notwithstanding Sub rules 1. and 2. Other supporting arrangements are acceptable if the design, as determined by a competent individual or agency, provides for adequate support of the lines.

.4 Subrules 1., 2., and 3. are not applicable to transmission lines.

.2 Guy Strand

.1 Guy strand shall have adequate tensile strength and shall be galvanized steel wire not less than 6 mm in diameter, or other similar material.

.3 Anchors

.1 An anchor shall have sufficient strength to sustain the load at the point of attachment independent of the strength of the pole.

.2 An anchor shall be:

.1 A plate of an expanded anchor; or

.2 A power installed screw anchor; or

.3 A treated log not less than 300 mm in diameter and 2 m long buried horizontally at a depth of 2 m minimum and at right angles to the pull; or

.4 A rock anchor or other anchor designed to provide adequate support.

.4 Installation

.1 Plate and expanding anchors shall be installed against an undercut to bear on firm undisturbed soil.

.2 Guys assemblies shall be installed before any conductors are attached to the pole and located so that the guys will not be abraded by rubbing against any wire, pole, or structure.

.3 Guys located so that there is a possibility of contact with supply conductors due to the failure of guys or conductors shall be effectively insulated.

.4 Notwithstanding Subrule 3.: Where engineering data is provided to justify an alternative design, guys for poles which carry only transmission lines need not be insulated, but shall be effectively bonded to ground.

.5 Guys and conductors shall be fitted with guards in any locations where there is a possibility of vehicle or pedestrian access such as on or near sidewalks, playgrounds, ski areas, and similar locations, except that where more than one guy is attached to a pole in the same direction, only the outer guy need be fitted with a guard.

.6 Guy strain insulators shall be installed so that:

.1 If the guy is hanging vertically, the lowest insulator will be at least 2.5 m above ground.

.2 If the guy should break loose from its anchor, there will be an insulator between the primary and secondary or ground conductors.

3. EXECUTION

3.1 Preparation of Poles

.1 Where poles require shortening, cut piece from top only.

.2 Roof top of poles with a single slope beveled top.

.3 Treat roof top, gains, bored holes with preservative before assembly.

.4 Cut parallel plane crossarm gains in face of pole for single and double arming, spacing as indicated.

.5 Bore hole in center of each gain for crossarm bolt.

.6 Drill crossarms for pins, through bolts, double arm bolts and brace bolts. Pre-drill treated crossarms to standard spacing.

.7 Fasten wood insulator pins to crossarms with galvanized steel nails.

.8 Install crossarms and braces.

.9 Install secondary racks.

3.2 Installation

.1 Locate and dig pole holes. Make holes large enough to allow space for tamping backfill.

.2 Pole Setting.

.1 The setting depth of a pole shall be at least 10% of the pole length plus 0.6 m, except that for a pole set in rock the setting depth shall be at least 10% of the pole length but not less that 1.2 m.

.2 Notwithstanding Subrule 1. Poles erected in a manner to provide equivalent strength will be accepted.

.3 Non-Pole Structures.

.1 Non-pole structures shall be set on approved foundations which shall be suitable for service conditions and design loads as defined by CAN/CSA C22.3 No. 1, or as dictated by specific local conditions.

.4 Align poles with crossarms at right angles to pole line on straight runs.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of conduit and fittings for installation of wiring.

2. PRODUCTS

2.1 Rigid Steel Conduit

.1 Galvanized with threaded joints and connections.

.2 Connections in dry locations: Steel or malleable iron locknuts inside and outside enclosures. Insulated bushings Thomas & Betts Series 222 or approved alternate.

.3 Connectors subjected to moisture interior and exterior: Liquid and dust tight with insulated throat, Thomas & Betts "Bullet Hub" 370 Series or approved alternate.

.4 Fittings: cast metal "Condulet" as manufactured by Crouse-Hinds Canada Ltd. including gasketted covers in damp locations.

.5 Expansion joints: cast metal Crouse-Hinds type XJ or approved alternate.

2.2 Flexible Conduit

.1 Connectors: Slip-proof, insulated throat or non-metallic bushings, steel, Thomas & Betts Ltd. "Tite-Bite", Series 300.

2.3 Liquid-Tight Flexible Conduit

.1 Conduit: Flexible metal conduit with liquid-tight PVC jacket. Industrial Wire & Cable "Liquiseal".

.2 Connectors: Captive sealing jacket and ground cone insulated throat, steel (Thomas & Betts Ltd. "Super-Tight", Series 6000).

3. EXECUTION

3.1 Rigid Steel Conduit

.1 Use as raceways for following applications:

.1 In all areas exposed to weather.

.2 In all areas where Teck cable is not used.

.3 For all fire alarm circuits and related wiring.

.4 For all lighting and receptacle power distribution.

.5 For all computer communication wiring.

3.2 Flexible Conduit

.1 Use as raceways for following applications:

.1 Connections to motors in dry locations.

.2 Flexible connections to luminaries.

.2 Provide a separate insulated ground wire in all flexible conduits.

3.3 Liquid-Tight Flexible Conduit

.1 Use as raceways for following applications:

.1 At all motors, pipe mounted control devices, and other devices subject to movement or water.

.2 At all motors provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus four (4) times the conduit diameter.

.3 Provide a separate ground wire within flexible conduit, bonded to motor frames and system ground.

3.4 Workmanship

.1 Install all conduit and wiring concealed, unless otherwise shown on the Drawings. Do not recess conduit in columns, except as noted, without permission.

.2 Where conduit is run exposed, run parallel to building lines. Where conduits are grouped (two (2) or more), space evenly, make bends concentric and mount on Unistrut racks.

.3 Lay out conduit to avoid interference with other Work. Maintain a minimum clearance of 150 mm from steam or hot water piping, vents, etc.

.4 Organize conduit in slabs to minimize crossovers.

.5 Where conduits or ducts enter or exit concrete structures below grade provide 16 mm x 1,500 mm steel reinforcing dowels to prevent shearing. Extend dowel 1,000 mm beyond concrete and band conduit to dowel. The first 3 m length of conduit extending from the structure to be Polykin wrapped rigid steel.

.6 Where steel conduit is required to be bent, do not heat, and do not bend conduit in such a way as to reduce pipe cross Section area at any point. Radii of bends shall be as per Canadian Electrical Code (CEC).

.7 For all runs of conduits, do not include more than equivalent of four (4) - quarter bends. Provide conduit fittings, pullboxes and junction boxes where necessary. Pulling elbows shall not be used except by special permission.

.8 Where possible, install conduits so that they are not trapped, cap turned up conduits to prevent the entrance of dirt of moisture during construction. Swab out conduit and thoroughly clean internally before wires and cables are pulled.

.9 Take extreme care in reaming ends of all conduit to ensure a smooth interior finish that will not damage the insulation of the wires.

.10 Use insulated non-metallic bushings on all conduit terminations.

.11 Ensure electrical continuity in all conduit systems.

.12 All conduit shown exposed in finished areas is to be free of unnecessary labels and trade marks.

.13 Install a 90 lb. test line in all conduits left empty by this Contractor including those which others will pull cables, wires, etc.

.14 Conduits and ducts crossing building expansion joints shall have conduit expansion fittings to suit the type of conduit used, and shall be Crouse-Hinds, Sceptre, or approved fitting.

.15 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant or approved equal.

.16 Where conduits pass through walls, they shall be grouped and installed through openings. After all conduits shown on the Drawings are installed, wall openings shall be closed with material compatible with the wall construction. Review size and quantity of conduit sleeves with the Contract Administrator.

.17 Where Drawings show conduit designations, these conduits shall be identified at each point of termination with Thomas & Betts "Ty-Rap" No. TY532M labels.

.18 Where conduit finish is damaged, repair or replace.

.19 Use "Condulet" fittings for power and telephone type conduit terminations in lieu of boxes where support is not provided.

.20 All branch circuit wiring, home-runs, communication and data to be minimum 20 mm diameter unless otherwise stated.

.21 Provide necessary flashing and pitch pockets, making watertight joints where conduits pass through roof or watertight membranes.

.22 Where panel board branch circuit conduits are amalgamated, size shall not exceed 25 mm diameter.

END OF SECTION

Conduit Raceway Schedule

RACEWAY SCHEDULE					
RACEWAY NUMBER	RACEWAY SIZE	RACEWAY TYPE	CABLE NUMBERS	RACEWAY REFERENCE DRAWINGS	REMARKS
CONDUITS					
C001	150mm	PVC In concrete encased envelope	P002A	CE1.02, CE1.07	5MVA transformer to UV Didtribution
C002	150mm	PVC In concrete encased envelope	P002B	CE1.02, CE1.07	5MVA transformer to UV Didtribution
C003	150mm	PVC In concrete encased envelope	P002C	CE1.02, CE1.07	5MVA transformer to UV Didtribution
C004	150mm	PVC In concrete encased envelope (Spare)		CE1.02, CE1.07	5MVA transformer to UV Didtribution
C005	150mm	PVC In concrete encased envelope (Spare)		CE1.02, CE1.07	5MVA transformer to UV Didtribution
C006	150mm	PVC In concrete encased envelope (Spare)		CE1.02, CE1.07	5MVA transformer to UV Didtribution
C007	150mm	PVC Direct Buried in Trench	P003A	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C008	150mm	PVC Direct Buried in Trench	P003B	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C009	150mm	PVC Direct Buried in Trench		CE1.02, CE1.07	Admin Bldg. To Manhole #1
C010	150mm	PVC Direct Buried in Trench		CE1.02, CE1.07	Admin Bldg. To Manhole #1
C011	75mm	PVC Direct Buried in Trench	Fire alarm	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C012	75mm	PVC Direct Buried in Trench	Fire alarm (Spare)	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C013	75mm	PVC Direct Buried in Trench	CCTV	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C014	75mm	PVC Direct Buried in Trench	CCTV (Spare)	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C015	75mm	PVC Direct Buried in Trench	Security	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C016	75mm	PVC Direct Buried in Trench	Security (Spare)	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C017	75mm	PVC Direct Buried in Trench	Instrumentation	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C018	75mm	PVC Direct Buried in Trench	Instrumentation (Spare)	CE1.02, CE1.07	Admin Bldg. To Manhole #1
C029	150mm	PVC Direct Buried in Trench	P003A	CE1.02, CE1.07	Manhole #1 to Manhole #2
C020	150mm	PVC Direct Buried in Trench	P003B	CE1.02, CE1.07	Manhole #1 to Manhole #2
C021	150mm	PVC Direct Buried in Trench		CE1.02, CE1.07	Manhole #1 to Manhole #2
C022	150mm	PVC Direct Buried in Trench		CE1.02, CE1.07	Manhole #1 to Manhole #2
C023	75mm	PVC Direct Buried in Trench	Fire alarm	CE1.02, CE1.07	Manhole #1 to Manhole #2
C024	75mm	PVC Direct Buried in Trench	Fire alarm (Spare)	CE1.02, CE1.07	Manhole #1 to Manhole #2
C025	75mm	PVC Direct Buried in Trench	CCTV	CE1.02, CE1.07	Manhole #1 to Manhole #2
C026	75mm	PVC Direct Buried in Trench	CCTV (Spare)	CE1.02, CE1.07	Manhole #1 to Manhole #2
C027	75mm	PVC Direct Buried in Trench	Security	CE1.02, CE1.07	Manhole #1 to Manhole #2
C028	75mm	PVC Direct Buried in Trench	Security (Spare)	CE1.02, CE1.07	Manhole #1 to Manhole #2
C029	75mm	PVC Direct Buried in Trench	Instrumentation	CE1.02, CE1.07	Manhole #1 to Manhole #2
C030	75mm	PVC Direct Buried in Trench	Instrumentation (Spare)	CE1.02, CE1.07	Manhole #1 to Manhole #2
C031	150mm	PVC In concrete encased envelope	P003A	CE1.02, CE1.07	Manhole #2 to UV Distribution
C032	150mm	PVC In concrete encased envelope	P003B	CE1.02, CE1.07	Manhole #2 to UV Distribution
C033	150mm	PVC In concrete encased envelope (Spare)		CE1.02, CE1.07	Manhole #2 to UV Distribution
C034	150mm	PVC In concrete encased envelope (Spare)		CE1.02, CE1.07	Manhole #2 to UV Distribution
C035	75mm	PVC In concrete encased envelope	Fire alarm	CE1.02, CE1.07	Manhole #2 to Control Room
C036	75mm	PVC In concrete encased envelope	Fire alarm (Spare)	CE1.02, CE1.07	Manhole #2 to Control Room
C037	75mm	PVC In concrete encased envelope	CCTV	CE1.02, CE1.07	Manhole #2 to Control Room
C038	75mm	PVC In concrete encased envelope	CCTV (Spare)	CE1.02, CE1.07	Manhole #2 to Control Room
C039	75mm	PVC In concrete encased envelope	Security	CE1.02, CE1.07	Manhole #2 to Control Room
C040	75mm	PVC In concrete encased envelope	Security (Spare)	CE1.02, CE1.07	Manhole #2 to Control Room
C041	75mm	PVC In concrete encased envelope	Instrumentation	CE1.02, CE1.07	Manhole #2 to Control Room
C042	75mm	PVC In concrete encased envelope	Instrumentation (Spare)	CE1.02, CE1.07	Manhole #2 to Control Room

CABLETROUGHS

1. GENERAL

1.1 Description

.1 Provide a complete system of cable trays as shown on the Drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Related Work

.1 Wire and Cables 0 - 1000V: Section 16122

.2 Fastenings and Supports: Section 16191

1.3 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate various types of cabletroughs with terminology used in Part 2.

2. PRODUCTS

2.1 Cabletrough

.1 Cabletroughs and fittings: to Electrical and Electronic Manufacturer's Association of Canada (EEMAC) F5-1.

.2 Ventilated type, Class C1 to Canadian Standards Association (CSA) C22.2 No.126.

.3 Ladder tray, 150 mm rung space, class C1 to CSA C22.2 No. 126.

.4 Galvanized steel tray 150, 300, 450 or 600 mm wide as required with depth of 75 mm.

.5 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers and other fittings where required. Radii on fittings: 600 mm minimum.

.6 Barriers where different voltage systems or electrical systems are in the same cabletrough, or as indicated.

.7 Approved materials: Pilgrim, Enduro, Canstrut, Pursley, Newton Instrument Co., or approved equal.

2.2 Supports

.1 Provide hardened steel (HS) rod hangers, rod hanger clamps and accessories as required.

.2 Provide U-channel support structures for cabletroughs supported from floor.

.3 Approved materials: Same as cabletrough.

3. EXECUTION

3.1 Installation

.1 Install complete cabletrough system. Provide concrete curbs around openings passing through floors.

.2 Support cabletrough on both sides at 1,500 mm, on centre, spacing.

.3 Provide additional support system for cabletroughs as may be deemed necessary to provide a secure system.

.4 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.

.5 Fire stop all penetrations of fire barriers.

.6 Install bare ground cable in all new trough system and bond to trough as required by the Canadian Electrical Code (CEC).

3.2 Cables in Cabletrough

.1 Install cables individually.

.2 Lay cables into cabletrough. Use rollers when necessary to pull cables.

.3 Secure cables in cabletrough at 5 m centers, with nylon ties.

.4 Identify cables every 30 m with nameplates in accordance with Section 16010 - Electrical General Requirements.

.5 Mark power and communication runs in accordance with colour coding outlined in Section 16010 - Electrical General Requirements.

CABLETROUGHS

END OF SECTION

RACEWAY SCHEDULE					
RACEWAY MUMBER	RACEWAY SIZE	RACEWAY TYPE	CABLE NUMBERS	RACEWAY REFERENCE DRAWINGS	REMARKS
CABLE TRAY					
T001	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P004, P005	E1.04	
T002	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P006,P007	E1.04	
T003	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P007	E1.04	
T004	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P006	E1.04	
T005	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P028, P029, P030	E1.04	
T006	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P031, P032	E1.04	
T007	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P028, P029, P030, P031, P032	E2.02	
T008	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P015, P016, P017, P038	E1.04	
T009	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P012, P013, P014	E1.04	
T010	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P018, P019, P020	E1.04	
T011	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P018	E1.04	
T012	600mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P019, P020	E1.04	
T013	300mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P021, P022	E1.04	
T014	300mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	Control	E2.02	
T015	300mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	Control	E1.04	
T016	300mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	Control	E1.04	
T017	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P003	E101, E2.04	
T018	450mm	CABLE TRAY-GALVANIZED STEEL CSA C1-75mm DEEP	P003	E1.01	

Notes
1. All Cable Tray to be rigidly supported from wall, roof structure or floor to suit the specific application.

BUSWAYS

1. GENERAL

1.1 Description

.1 Provide a complete system of busways as shown on the Drawings.

.2 Coordinate the location of the support channels so as not to interfere with other services.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate in detail exact routing of busways throughout building and in relation to column lines and structural slabs and walls. Provide drop test results for each size of busway.

2. PRODUCTS

2.1 General

.1 Feeder and plug-in type busways to be complete system of shop fabricated interconnecting busways as indicated on Drawings. Fabricate busways in 3,048 mm lengths or in shorter lengths to suit field conditions or duct fittings.

.2 200% neutral for Ultraviolet (UV) Distribution bus.

.3 Totally enclosed (interior) and totally enclosed weatherproof (exterior) in Canadian Standards Association (CSA) Enclosure 3 housing.

.4 Line to line voltage drop not exceeding 1.5V per 30 m at rated current with distributed load at any system power factor.

.5 Internal fire barriers at floor/wall penetrations complete with flanges.

2.2 Bus

.1 Copper, sized for the ratings indicated, silver flashed at all joints, connections fitting locations. Wrap with two (2) layers of carnished cambric tape or equivalent insulation. Bus bars to be rated for 55°C rise over a maximum ambient of 40ºC, but insulation be rated for 105°C.

2.3 Ratings

.1 Busways to be rated 347/600V, three (3) phase, four (4) conductors with neutral capacity indicated in Clause 2.1 and as indicated on the Drawings. Brace bus bars to withstand 100 kA symmetrical three (3) phase, 60 Hertz, short circuit at 600 volts. Ampere ratings of busway to be as indicated on Drawings. If busway has different ampere rating when mounted vertically or horizontally, use the lower rating and provide same duct and bus bar size for horizontal and vertical installation. Busway minimum ratings must equal ratings indicated. Select busway design to reduce electrical impedance. Voltage drops at 95% power factor to be in accordance with Manufacturer's data sheets at the time of tender.

2.4 Ground

.1 Provide a continuous ground in all feeder distribution busway Sections to provide low impedance ground path.

2.5 Fire Barriers

.1 At all locations where busways pass through fire retarding walls or floors, provide approved fire barriers sealing busway penetrations. Use non-tracking fire barrier material that will not absorb moisture.

2.6 Fittings

.1 Provide complete system of fittings for busway installation, including:

- Transformer tap-offs.
- Flanged throats for connection to switchboards and motor control centres.
- Tee and angle fittings, tap-off boxes, end caps, elbows, reducers and offsets.
- Special short busway lengths to suit field conditions.
- Joint fittings, splice plates and coverplates.
- End fittings.
- Busway clamp hanger frames.
- Expansion joints on vertical and horizontal busway runs at all locations to suit layout as recommended by Manufacturer and where busway crosses building expansion joint.

2.7 Hangers and Supports

.1 Provide a complete system of hangers and supports, generally as indicated on Drawings or required for installation shown. Use busway clamp hanger frames to

clamp to busway. Provide light field welded angle iron brackets to transfer weight of busway to building structure. Spacing of supports to be as shown on Drawings and as required by CSA Code. For vertical riser busways, provide brackets to transfer weight of busway to building structure at each support.

2.8 Finish

.1 Clean and de-scale all metal parts. Apply a zinc-chromate prime coat and two (2) coats of spray enamel to exterior and interior surfaces as per Section 16010 - Electrical General Requirements. Use cadmium plated or corrosion resistant bolts for all bolted connections.

2.9 Main Service Feeder Busway

.1 Provide low impedance feeder busway from transformer secondary throat connections to main secondary switchboard. Match busway flanges to transformer and switchboard flanges. Use two (2) bus bars per phase arranged in symmetrical pattern so that bars of opposite polarity are adjacent to each other.

2.10 Manufacturers

.1 Eaton Cutler Hammer.

.2 Schneider Electric.

3. EXECUTION

3.1 Installation

.1 Before manufacture, field measure all critical and non-standard lengths of busway. Do not scale from Drawings. Install all off-sets, corners and elbows to suit job conditions.

.2 Provide all necessary miscellaneous fittings space hangers and brackets. Provide a complete system of independent support for all busway runs. Connect from supports to busway clamp hanger fittings. Space hangers in accordance with Manufacturer’s recommendation, maximum spacing 3 m. Where hanging supports are not practical, floor mounted support systems shall be provide. These floor mount support systems shall not interfere with the operation or clearances required.

.3 Torque bolts in accordance with Manufacturer's recommendations. Record torques and advise Contract Administrator in writing. Re-torque all connections after no more than six (6) months after energizing and report to Contract Administrator in writing.

.4 Cover busway with plastic envelope until building is clean and bus ready to be meggered and energized.

.5 Connect all busway Sections in the presence of the Contract Administrator and have readings approved before energizing.

.6 Provide lamicoid plate identification on outside of busway covers. Install identification plates wherever busways enter or leave an area, and at all tee fittings, but do not duplicate identification, if identification at one location is sufficient. Show busway designation, voltage and source of feed: UV Influent Pump Distribution, 347/600 Volts, fed from UV Influent Pump Transformer.

.7 Provide one (1) torque wrench and head to match each type of bolt used and turn over to the City.

.8 Locate expansion joints as shown on the Drawings.

.9 Coordinate concrete curbed slots at all points the busways passed through floors.

.10 Install all fire barriers where required.

END OF SECTION

WIREWAYS AND AUXILIARY GUTTERS

1. GENERAL

1.1 Description

.1 Supply and install wireways and auxiliary gutters and fittings as a means for flexible wiring system.

.2 All wireways and gutters to be two (2) piece with removable cover to provide access to wiring.

.3 Wireways, auxiliary gutters and fittings are based on Canadian Standards Association (CSA) CSS.2, No. 26.

1.2 Submittals

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Wireways

.1 Sheet steel with bolted cover to give uninterrupted access.

.2 Finish: based gray enamel.

.3 Elbows, tees, couplings and hanger fittings manufactured as accessories to wireway supplied.

3. EXECUTION

3.1 Installation

.1 Install wireways and auxiliary gutters.

.2 Keep number of elbows, offsets, and connections to minimum.

.3 Install supports, elbows, tees, connectors, and fittings.

.4 Install barriers to separate different voltages or to separate different systems.

.5 Install gutter to full length of equipment.

END OF SECTION

HV POWER CABLES & 15KV SHIELDED CABLE TERMINATIONS

1. GENERAL

1.1 Description

.1 Complete supply, installation and termination of power cables rated 15000 volts.

1.2 Codes and Standards

.1 Insulated cables to Canadian Standards Association (CSA) C22.2 No. 38, CSA C68.3 and ICEA 5-66-524.

2. PRODUCTS

2.1 Insulated Cables

.1 Three (3) conductors sized as indicated, copper stranded, with semi-conducting XLPE conductor shield.

.2 Insulation of chemically cross linked, thermosetting polypropylene material, rated RW-90 or RWU-90, 100 kV B.I.L.

.3 Insulation shielding of semi-conducting cross linked polyethylene over insulation and served wire or copper tape shield.

.4 Cable jacket thermosetting low temperature black, with separator tape between shield and jacket.

.5 Suitable for grounded neutral, 133% insulation level.

.6 Short circuit rating 60 kA, one (1) cycle; 14 kA, 30 cycle.

.7 90°C normal, 130°C emergency rating, 250°C short circuit rating.

2.2 Ground Conductor

.1 Minimum 2/0 AWG stranded soft drawn bare copper, 600 volt, green insulation.

.2 Alternatively, for multi-conductor cables, provide a stranded copper ground conductor, integral with the cable and sized according to Table 17 of the Canadian Electrical Code, Part I.

2.3 Connectors

.1 Where not provided with equipment, supply suitable compression type connectors for use on copper conductors.

2.4 Stress Cones

.1 Refer to Section 16121 - Power Cable and Overhead Conductors 1001-15000 V.

3. EXECUTION

3.1 Insulated Cables

.1 Do not splice cables. A continuous length is required for all feeds.

.2 Install in accordance with Manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.

.3 Submit certified Manufacturer's data sheets.

3.2 Terminations

.1 Form stress relief cones in accordance with Section 16121 - Power Cable and Overhead Conductors 1001-15000 V.

.2 Install compression connectors using tools provided by the connector Manufacturer in accordance with the Manufacturer's recommendations.

3.3 Tests

.1 The Electrical Contractor is to test cables prior to energization, as follows:

- Megger.
- Highpot.
- 25 kV DC ICEA.
- Radar scan shield test.

END OF SECTION

POWER CABLE AND OVERHEAD CONDUCTORS 66 kV

1. GENERAL

1.1 Description

.1 This Specification covers the requirements for the construction of overhead 66 kV power lines and underground 66 kV cables.

1.2 Related Work

.1 The Line Voltage is 66 kV supplied by Manitoba Hydro.

.2 Line design and construction shall satisfy the requirements of Canadian Standards Association (CSA) C22.1, Safety Standards for Electrical Installation and CAN/CSA C22.3 No. 1, Overhead Systems. Lines shall be designed for operation at the highest voltage expected. The primary line on private property, not owned and operated by the supply authority but connected to the authority's system, shall have service disconnect equipment mounted on the privately owned pole coolest to the supply authority's system. Service disconnect equipment shall conform to the requirements of Section 36 of the Canadian Electrical Code; and simultaneously disconnect all live lines. The 66kV Switch shall be a Travis Pattern and Foundry Inc. (Patton & Cooke) Cat No. VM-3696-VBWH. Overcurrent protection shall be provided prior to any taps connected to the overhead line. Except for dead-end and corner poles, the line on private property shall be free standing without depending upon its attachments to the supply authority plant for support. The line shall have insulation and reliability levels acceptable to the supply authority.

.3 The last pole, which shall be located within 15 m from the supply authority's service pole, shall be no longer than 12.2 m (45 ft) and shall be adequate to support the overhead line dead end, 66 kV fuses, underground cable terminations, lightning arrestors and any associated hardware and insulators.

.4 The 66 kV cable structure design shall be determined by a competent individual or agency and shall support the cables, cable risers, fuses, lightning arresters and overhead line terminations. The cables shall be supported by appropriate hardware and shall be located such as to maintain clearances required to eliminate the possibility of flashover at the basic impulse level according to Manitoba Hydro practices and requirements.

.5 The cables shall be 69 kV cross-linked polyethylene insulated and constructed to AEIC CS7 with a minimum average 650 mils of insulation. The sheath shall be of copper welded corrugated design of at least 25 mils in thickness.

.6 The underground 69 kV cables shall be installed in a bed of 6 mm (1/4 in) and down limestone within 75 mm concrete curbs of height sufficient to encapsulate the whole

bed and cables as described below. The cables themselves shall be at least 1.5 m below grade with a minimum bending radius of 1.5 m. The limestone shall extend 100 mm below the cables, 150 mm above and 100 mm on either side of the cables. The 100 mm below shall compact prior to the laying of the cables. The final limestone 150 mm lift (above the cables) shall be compacted prior to the installation of the 50 mm patio slabs cap specified herein. The cables shall be spaced at least one (1) cable diameter apart. The installation of the cables must be made at ambient temperatures above -10 degrees C.

.7 The cables shall be terminated using Raychem Cat. No. GHVT-692-SG or approved 3M equivalent. These are to be installed only by qualified cable terminators trained by the Manufacturer.

.8 Connection to a Supply Authority System - the electrical and mechanical contact between a private overhead line and a supply authority system shall be made only:

.1 With the acceptance of the Supply Authority.

.2 By the supply authority or its agent.

2. PRODUCTS

2.1 Overhead Line Conductors

.1 Overhead line conductors shall be of #2/0 AWG ACSR meeting the requirements of CEA WCWG-03.

2.2 Overhead Line Insulators

.1 Shall be designed, manufactured and tested to meet the requirements of CEA LWIWG-01 or LWIWG-02 as appropriate.

3. EXECUTION

3.1 Installation

.1 Install primary cables on pole line in accordance with Section 16108- Pole Line and Hardware.

.2 Install primary cables in accordance with Canadian Electrical Code, Manitoba Hydro standards and practices and as described above.

.3 Conductors and wires shall be sagged in such a manner so as to meet the loading and clearances requirements of Section 104 of CAN/CSA C22.3 No.1

.4 An overhead line that is being erected with the intent that it may be taken over to be owned and operated by the supply authority, will have to meet the requirements of the supply authority. A Contractor or Owner erecting such a line is advised to obtain confirmation from the supply authority that all necessary conditions have been met.

.5 Wires and conductors suspended between two (2) points will have varying sag, clearance, and separations due to the following phenomena:

.1 Wind and ice loadings.

.2 Thermal expansion and contractions caused by variations in ambient temperature, solar radiation, and air movement.

.3 Thermal expansion and contractions caused by changes in electrical loading of electrical conductors.

.4 Mechanical creep, which is a permanent elongation of wires and conductors caused by mechanical and thermal loadings.

The overall effect on sag, clearance, and separation varies considerably with the material and design of the conductor or wire, with the pre-loaded and initial tensions, and with span length.

The phenomena can act simultaneously to cause a cumulative effect and will usually result in a large variation in the sag, clearance and separation of wire or conductor. This variation may, theoretically, be almost continuous if the separate parameters are varying from hour to hour. The overall effect is particularly complex when multiple circuits of different characteristics are involved such as when circuits cross, or when multiple circuits share the same pole.

The sags, clearances, and separations referred to in this Standard and in CAN/CSA C22.3 No. 1 are the maximum or minimum permissible under the prescribed loading conditions, unless otherwise stated.

.6 Sags, clearances, and separations can vary considerably. As a result, measurements taken in the field at an instant in time will only indicate the sag, clearance or separation for the prevailing mechanical and thermal conditions at the time the measurements are taken. Simple field measurements do not guarantee that the conductor or wire will meet the clearance requirements specified in this Standard for all service conditions. Complex calculations, or the use of charts and tables, are usually required to transform the measurement data into sag, clearances, and separations at the specified maximum conductor or wire, mechanical and/or electrical loadings.

Constructing a line with exceptionally large clearances and separations is one method of ensuring that the sagging of conductor or wire under service conditions will not contravene the clearance and separation requirements of these regulations.

.7 See Workers' Compensation Board (WCB) Regulations for minimum clearances required when working in close proximity to lines.

.8 Supply conductors opening above 750 V are not permitted to be attached directly to buildings except at generating stations and substations.

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 shown on Drawings.

1.2 References, Codes and Standards

.1 Canadian Standards Association (CSA) C22.2 No. 0.3, Test Methods for Electrical Wires and Cables.

.2 Install and rate power cables in accordance with the Canadian Electrical Code requirements.

1.3 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Building Wires

.1 Conductors: stranded for 10 AWG and larger. Minimum size: 12 AWG.

.2 Copper conductors: size as indicated, 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 indicated.

.2 Insulation:

.1 Type: ethylene propylene rubber.

.2 Chemically XLPE rated type RW90, 1000 V.

.3 Inner jacket: polyvinyl chloride material.

.4 Armour: interlocking aluminum.

.5 Overall covering: thermoplastic polyvinyl chloride material.

.6 Fastenings:

.1 One (1) hole malleable iron 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 at 1,500 mm centers.

.3 6 mm dia. threaded rods to support suspended channels.

.7 Connectors:

.1 Watertight, approved for TECK cable.

2.3 Control Cables

.1 Single conductor wire to be 98% conductivity copper type TEW or TBS insulation rated at 600 V, solid or stranded conductor as required, size as noted on Drawings and specified herein, 90^0C insulation and manufactured to CSA Specification C22.2, No. 38.

.2 Cable for power and control shall be based on Teck 90 armoured cable, with stranded copper conductors, 90^0 C insulation, rated at 600 V ac, manufactured to CSA Specification C22.2, No. 131, integral copper ground wire, PVC inner jacket, aluminum interlocking armour, and PVC outer jacket having heat, flame, and moisture retardant properties. Flame retardancy of outer jacket to be rated in accordance with CSA Standard C22.2, No. 0.3.

.3 Analog instrumentation cable shall use single or multiple pair, seven (7) strand copper conductor, individually twisted and shielded, individual tinned copper drain wire, complete electrical isolation between shields, overall multi-conductor cable shield with drain wire, XLPE inner jacket, interlocking aluminum armour, and FT4 flame retardant rated outer PVC jacket. Cable to be manufactured to CSA Specifications C22.2, No. 239 and CSA, No. 38 and shall be provided with a black, white, colour code and number code for each pair. Cable and conductor insulation to be rated for 105^0C (dry) and 600 V. Conductor size shall be minimum #16 AWG or as noted on the Drawings. Standard of acceptance shall be Shawflex 69 series instrumentation and control cable.

3. EXECUTION

3.1 General

.1 Minimum conductor size #12 AWG except for luminaire drops which can be #14 AWG if fed from 15A circuits.

3.2 Installation of Building Wires

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 16111.

.2 In cabletroughs in accordance with Section 16114.

.3 In wire ways and auxiliary gutters in accordance with Section 16116.

3.3 Installation of Teck Cable 0 - 1000 V

.1 Install cables.

.2 Group cables wherever possible on channels.

.3 Lay cable in cabletroughs in accordance with Section 16114.

.4 Terminate cables in accordance with Section 16151 - Wire and Box Connectors - 0 - 1000 V.

3.4 Installation of Control Cables

.1 Install control cables in conduit or cable troughs.

.2 Ground control cable shield at one end only. Shields to be continuous over entire run.

3.5 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. Do not pull wires into incomplete conduit runs.

.2 Installation to be free of opens and grounds. Before energization, measure insulation resistance and comply with the Canadian Electrical Code (CEC). Submit data sheet with values measured.

.3 Do not Install any conductor smaller than #12 AWG, except where specifically indicated otherwise, i.e., for fire alarm system station circuits, P.A. wiring, etc.

.4 Provide sizes of conductors as shown on Drawings. Voltage drop from lighting panels to farthest outlet must not exceed 2% at full load in any case. Advise Contract Administrator if problem is foreseen.

.5 Exercise care in stripping insulation from wire. Do not nick conductors.

3.6 Identification, Coding and Balancing

.1 For branch circuit wiring, follow identification system shown on the Drawings and as specified in Section 16010 - Electrical General Requirements.

.2 Connect single phase equipment to minimize imbalance on feeders. Adjust branch circuiting shown as required for optimum balancing. Record all changes on "record" Drawings.

.3 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 wraps of 3M #471 plastic film tape 48 mm wide.

.4 Conductors sized No. 10 and smaller are required to be factory coloured, not taped on Site.

.5 For direct current wiring use red for positive and black for negative.

3.7 Testing

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt 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

Power Cable List

CABLE SCHEDULE						
CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
POWER CABLES						
P001	66kV	Overhead/under ground	Hydro Fused Disconnect	Transformer PDT-1	Supplied by Manitoba Hydro	
P002A,B & C	3-3/C 350MCM external 4/0 Ground	Underground Concrete Duct	Transformer PDT-1	Breaker 52-L1 UV Bldg.	8kV TRXLPE Power	Pirelli Cable 375A per cable
P003A & B	2-3/C 500MCM Plus External 4/0 Ground	Existng Duct Git Building Tray in Exting pipe Gallery Tray in Admin. Bldg. Underground PVC Duct Via Manhole 1 and 2	Grit Bldg. Distribution New 5kV Breaker	Breaker 52-L2 UV Bldg.	8kV TRXLPE Armortek	Pirelli Cable 535A per cable
P004	2-3/C 350MCM Plus Ground	Cable Tray T001	5kV Breaker 52-UVT2	Transformer UVT-2	8kV TRLPE Armortek	Pirelli Cable 435A per cable
P005	2-3/C 350MCM Plus Ground	Cable Tray T001	5kV Breaker 52-UVT3	Transformer UVT-3	8kV TRLPE Armortek	Pirelli Cable 435A per cable
P006	3/C #2/0 Plus Ground	Cable Tray T002, T004	5kV Breaker 52-LST4	Transfromer LST-4	8kV TRLPE Armortek	Pirelli Cable 245A per cable
P007	3/C #2/0 Plus Ground	Cable Tray T002, T003	5kV Breaker 52-LST5	Transformer LST-5	8kV TRLPE Armortek	Pirelli Cable 245A per cable
P008	5000 Amp Bus Duct, 100% GRD, 200% Neutral		Tranformer UVT-2	Breaker 480-B1	600V/3Ø/4 Wire	
P009	5000 Amp Bus Duct, 100% GRD, 200% Neutral		Transformer UVT-3	Breaker 480-B2	600V/3Ø/4 Wire	
P010	1600 Amp Bus Duct, 100% GRD		Transformer LST-4	Breaker 600-B1	600V/3Ø/3 Wire	
P011	1600 Amp Bus Duct, 100% GRD		Transformer LST-5	Breaker 600-B2	600V/3Ø/3 Wire	
P012	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T009	Breaker 480-B8 UV Distribution	Trojan PDC-3B	1kV R90 Teck	
P013	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T009	Breaker 480-B7 UV Distribution	Trojan PDC-2B	1kV R90 Teck	
P014	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T009	Breaker 480-B6 UV Distribution	Trojan PDC-1B	1kV R90 Teck	
P015	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T008	Breaker 480-B5 UV Distribution	Trojan PDC-3A	1kV R90 Teck	
P016	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T008	Breaker 480-B4 UV Distribution	Trojan PDC-2A	1kV R90 Teck	
P017	3-4/C 350MCM, 100% GRD, 200% Neutral	Cable Tray T008	Breaker 480-B3 UV Distribution	Trojan PDC-1A	1kV R90 Teck	
P018	1-3/C 4/0 plus GRD	Cable Tray T010, T011	Breaker 600-B3	Harmonic Filter U-050-HF-P5	1kV R90 Teck	
P019	1-3/C 4/0 plus GRD	Cable Tray T010, T012	Breaker 600-B4	Harmonic Filter U-040-HF-P4	1kV R90 Teck	
P020	1-3/C 4/0 plus GRD	Cable Tray T010, T012	Breaker 600-B5	Harmonic Filter U-030-HF-P3	1kV R90 Teck	
P021	1-3/C 4/0 plus GRD	Cable Tray T013	Breaker 600-B6	Harmonic Filter U-020-HF-P2	1kV R90 Teck	
P022	1-3/C 4/0 plus GRD	Cable Tray T013	Breaker 600-B7	Harmonic Filter U-010-HF-P1	1kV R90 Teck	
P023	1-3/C 4/0 plus GRD		Harmonic Filter U-050-HF-P5	U-050-VFD-P5	1kV R90 Teck	
P024	1-3/C 4/0 plus GRD		Harmonic Filter U-040-HF-P4	U-040-VFD-P4	1kV R90 Teck	
P025	1-3/C 4/0 plus GRD		Harmonic Filter U-030-HF-P3	U-030-VFD-P3	1kV R90 Teck	
P026	1-3/C 4/0 plus GRD		Harmonic Filter U-020-HF-P2	U-020-VFD-P2	1kV R90 Teck	
P027	1-3/C 4/0 plus GRD		Harmonic Filter U-010-HF-P1	U-010-VFD-P1	1kV R90 Teck	
P028	1-3/C 4/0 plus GRD	Cable Tray T005, T007	U-050-VFD-P5	Disconnect Cabinet P-5	1kV R90 Teck	
P029	1-3/C 4/0 plus GRD	Cable Tray T005, T007	U-040-VFD-P4	Disconnect Cabinet P-4	1kV R90 Teck	
P030	1-3/C 4/0 plus GRD	Cable Tray T005, T007	U-030-VFD-P3	Disconnect Cabinet P-3	1kV R90 Teck	
P031	1-3/C 4/0 plus GRD	Cable Tray T006,T007	U-020-VFD-P2	Disconnect Cabinet P-2	1kV R90 Teck	
P032	1-3/C 4/0 plus GRD	Cable Tray T006,T007	U-010-VFD-P1	Disconnect Cabinet P-1	1kV R90 Teck	
P033	Pump Supplier Cable		Disconnect Cabinet P-5	Pump U-050-P5		Cable supplied with Pumps. Connect to associated disconnect cabinet.
P034	Pump Supplier Cable		Disconnect Cabinet P-4	Pump U-040-P4		
P035	Pump Supplier Cable		Disconnect Cabinet P-3	Pump U-030-P3		
P036	Pump Supplier Cable		Disconnect Cabinet P-2	Pump U-020-P2		
P037	Pump Supplier Cable		Disconnect Cabinet P-1	Pump U-010-P1		
P038	1-3/C 350MCM	Cable Tray T008	Breaker 600-B8	CDP 100	1kV R90 Teck	

Power Cable List

CABLE SCHEDULE						
CABLE NUMBER	CABLE TYPE	CABLE ROUTING	ORIGIN	DESTINATION	DESCRIPTION	REMARKS
POWER CABLES						
P039	1-3/C #2		CDP 100	Transformer DT-6	1kV R90 Teck	
P040	1-4/C 250MCM		Transfromer DT-6	Panel A	1kV R90 Teck	
P041	4#2 R90	Conduit	Panel A	Panel B	600V R90	
P042	3#4 R90 Plus Ground	Direct Buried	Panel A	Panel C	600V R90 Teck	

CONTROL CABLE LIST

CABLE SCHEDULE						
CABLE NUMBER	CABLE TYPE		ORIGIN	DESTINATION	DESCRIPTION	REMARKS
CCTV-001	RG-59 Coaxial	Conduit as required	CCTV Camera 001	UV Control Panel UV CP1	Camera Video	Refer to CI1.01
CCTV-001A	RG-59 Coaxial	C013,C025,C037	Process Control Wiring Closet	Existing City CCTV Multiplexor	Camera Video	Refer to CI1.01
CCTV-002	RG-59 Coaxial	Conduit as required	CCTV Camera 002	UV Control Panel UV CP1	Camera Video	Refer to CI1.01
CCTV-002A	RG-59 Coaxial	C013,C025,C037	Process Control Wiring Closet	Existing City CCTV Multiplexor	Camera Video	Refer to CI1.01
CCTV-003	RG-59 Coaxial	Conduit as required	CCTV Camera 003	UV Control Panel UV CP1	Camera Video	Refer to CI1.01
CCTV-003A	RG-59 Coaxial	C013,C025,C037	Process Control Wiring Closet	Existing City CCTV Multiplexor	Camera Video	Refer to CI1.01
CCTV-004	RG-59 Coaxial	Conduit as required	CCTV Camera 004	UV Control Panel UV CP1	Camera Video	Refer to CI1.01
CCTV-004A	RG-59 Coaxial	C013,C025,C037	Process Control Wiring Closet	Existing City CCTV Multiplexor	Camera Video	Refer to CI1.01
PCV-001	Category 5	Conduit as required	UV PCV Operator Workstation	UV Control Panel UV CP1	PCV Ethernet network cable	Refer to CI1.01
SCC-001	Category 5	Conduit as required	UV SCC	UV Control Panel UV CP1	PLC Communication to DCS	Refer to CI1.01
UV CP1-001	12 Fiber 62.5/125 µM Glass Multimode	C017,C029,C041	UV Control Panel UV CP1	Process Control Wiring Closet	Communication to Admin Buildir	Refer to CI1.01
UV CP1-002	12 Fiber 62.5/125 µM Glass Multimode	C017,C029,C041	UV Control Panel UV CP1	Process Control Wiring Closet	Communication to Admin Buildir	Refer to CI1.01
U002-1	15/C #14 Teck Cable	UG to Grit Bldg, cable tray in Bldg	U002-HS1,HS2,HS3,ZSD,ZSB	Grit Building Control Center	U-002 SG-1	Refer to ILD-01
U005-1	1/PR/TW/SH Belden 8760 Teck	UG to UV Bdg, cable tray to UVCP1	U005-LIT	UV Control Panel UV CP1	Level Contol	Refer to P1.04, ILD-02
U010-1	4/PR/TW/SH	Conduit as required	U010-SC, SIT	UV Control Panel UV CP1	Speed	Refer to P1.10,ILD-03
U010-2	10/C #14	Conduit as required	U010-IIT,MM,UF,MN,YS	UV Control Panel UV CP1	Control	Refer to P1.10,ILD03
U020-1	4/PR/TW/SH	Conduit as required	U020-SC, SIT	UV Control Panel UV CP1	Speed	Refer to P1.10,ILD03
U020-2	10/C #14	Conduit as required	U020-IIT,MM,UF,MN,YS	UV Control Panel UV CP1	Control	Refer to P1.10,ILD03
U030-1	4/PR/TW/SH	Conduit as required	U030-SC,SIT	UV Control Panel UV CP1	Speed	Refer to P1.10,ILD-03
U030-2	10/C #14	Conduit as required	U030-IIT,MM,UF,MN, YS	UV Control Panel UV CP1	Control	Refer to P1.10,ILD-03
U040-1	4/PR/TW/SH	Conduit as required	U040-SC,SIT	UV Control Panel UV CP1	Speed	Refer to P1.10,ILD-03
U040-2	10/C #14	Conduit as required	U040-IIT,MM,UF,MN,YS	UV Control Panel UV CP1	Control	Refer to P1.10,ILD-03
U050-1	4/PR/TW/SH	Conduit as required	U050-SC,SIT	UV Control Panel UV CP1	Speed	Refer to P1.10,ILD-03
U050-2	10/C #14	Conduit as required	U050-IIT,MM,UF,MN,YS	UV Control Panel UV CP1	Control	Refer to P1.10,ILD-03
U060-1	2/PR/TW/SH Belden 8760	Conduit as required	U060-LIT	System Control Centre (SCC)	Discharge Channel Level/Flow	Refer to P1.11
U070-1	20/C#14	Conduit as required	System Control Centre (SCC)	UV Control Panel UV CP1	Control	Refer to P1.11,ILD-04
U100-1	7/C#14 Teck	Conduit as required	U100-SG1	System Control Centre (SCC)	Control	Refer to ILD05,P1-14
U100-2	3/PR/TW/SH Belden 8760 Teck	Conduit as required	U100-SG1	System Control Centre (SCC)	Open, Close	Refer to ILD05,P1-14
U200-1	7/C#14 Teck	Conduit as required	U200-SG1	System Control Centre (SCC)	Control	Refer to ILD05,P1-14
U200-2	3/PR/TW/SH Belden 8760 Teck	Conduit as required	U200-SG1	System Control Centre (SCC)	Open, Close	Refer to ILD05,P1-14
U300-1	7/C#14 Teck	Conduit as required	U300-SG1	System Control Centre (SCC)	Control	Refer to ILD05,P1-14
U300-2	3/PR/TW/SH Belden 8760	Conduit as required	U300-SG1	System Control Centre (SCC)	Open, Close	Refer to ILD05,P1-14
U170-1	1/PR/TW/SH Belden 8760		U170-LT	System Control Centre (SCC)	Effluent Channel	Refer to P1.07
U270-1	1/PR/TW/SH Belden 8760		U270-LT	System Control Centre (SCC)	Effluent Channel	Refer to P1.08
U370-1	1/PR/TW/SH Belden 8760		U370-LT	System Control Centre (SCC)	Effluent Channel	Refer to P1.09
U900	4/C #14		Fire Alarm Panel	UV Control Panel UV CP1	Fire and Trouble Alarm	Refer to ILD-10
U930-1	10/C #14		Transformer PDT-1	UV Control Panel UV CP1	Transformer Alarms	Refer to ILD-07
U935-1	6/C #14		Transformer UVT-2	UV Control Panel UV CP1	Transformer Alarms	Refer to ILD-08
U940-1	6/C #14		Transformer UVT-3	UV Control Panel UV CP1	Transformer Alarms	Refer to ILD-08
U945-1	6/C #14		Transformer LST-4	UV Control Panel UV CP1	Transformer Alarms	Refer to ILD-08
U950-1	6/C #14		Transformer LST-5	UV Control Panel UV CP1	Transformer Alarms	Refer to ILD-08
U910-1	2/C #16		Motion Detector	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U911-1	2/C #16		Motion Detector	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U912-1	2/C #16		Motion Detector	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U913-1	2/C #16		Door Switch	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U914-1	2/C #16		Door Switch	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U915-1	2/C #16		Motion Detector	UV Control Panel UV CP1	Alarm	Refer to ILD-09
U916-1	2/C #16		Motion Detector	UV Control Panel UV CP1	Alarm	Refer to ILD-09

SPLITTERS, JUNCTION BOXES PULL BOXES AND CABINETS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of splitters boxes and cabinets for the installation of wiring and equipment.

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data for cabinets in accordance with Section 16010 Electrical General Requirements and Section 01300 Submittals.

2. PRODUCTS

2.1 Junction Boxes and Pull Boxes, Weatherproof

.1 Materials:

.1 Cast steel, Crouse Hinds, WBJ Series.

2.2 Junction Boxes and Pull Boxes, Indoor Dry Locations

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

.1 For flush mounting, covers to overlap box by 25 mm minimum all around with flush head cover retaining screws.

.2 Use rolled edges for surface boxes.

.3 Junction boxes mounted in exterior walls shall be complete with box vapour barriers.

2.3 Cabinets

.1 Materials:

.1 Cabinets: Code gauge sheet steel, welded construction, phosphatized and factory paint finish, suitable for field painting.

.2 Locks: to match panelboards.

.2 Components:

.1 With hinged door and return flange overlapping sides, with handle, lock and catch for surface mounting, size as indicated or to suit.

.2 Install a back mounting plate for DIN rail mounted terminal blocks. Plate to be painted white enamel.

.3 Install metal divider in cabinets with more than one voltage.

.4 Surface or flush with trim and hinged door, latch and lock and two keys, size as indicated or to suit. Keyed to match panelboard keys 19 mm.

2.4 Splitters

.1 Materials:

.1 Code gauge sheet steel, welded construction, phosphatized and factory paint finish.

.2 Components:

.1 Formed hinged cover suitable for locking in the closed position.

.2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 At least three (3) spare terminals on each set of lugs in splitters less than 400 AMP.

3. EXECUTION

3.1 Installation

.1 Junction Boxes and Pull Boxes:

.1 Supply all pull boxes and junction boxes shown on the Drawings or required for the installation.

.2 Boxes installed in party walls to be offset by a minimum of one stud space.

.3 Install in inconspicuous but accessible locations, above removable ceilings or in electrical rooms, utility rooms or storage areas.

.4 Identify with system name and circuit designation as applicable.

.5 Size in accordance with the Canadian Electrical Code (CEC), as a minimum.

.2 Cabinets:

.1 Mount cabinets with top not greater than 1,980 mm above finished floor, coordinated with masonry, panelboards, fire hose cabinets and similar items.

.2 Install terminal block where indicated.

.3 Splitters

.1 Install splitters and mount plumb, true and square to the building lines.

.2 Extend splitters full length of equipment arrangement except where indicated otherwise.

.4 Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

END OF SECTION

OUTLET BOXES, CONDUIT BOXES AND FITTINGS

1. GENERAL

1.1 Work Included

.1 Provide a complete system of boxes for the installation of wiring and equipment.

1.2 References

.1 Canadian Standards Association (CSA) C22.1-Canadian Electrical Codes (CEC), Part 1.

2. PRODUCTS

2.1 Outlet and Conduit Boxes General

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required for special devices.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 Combination boxes with barriers where outlets for more than one (1) system are grouped.

2.2 Outlet Boxes for Metal Conduit

.1 Materials:

.1 Surface mounting exposed: Cast ferrous for threaded conduit, with attached lugs, corrosion resistant two (2) coats finish.

.2 Components:

.1 Ceiling outlets, surface mounting:

.1 Cast outlet boxes suitable for rigid conduit.

.2 Crouse Hinds VXF/VFT series.

.2 Wall outlets, surface, exposed mounting or used for outdoor outlets: One or more gang, Crouse-Hinds FS series or FD series, condulet.

.3 Covers: Unless wiring devices and plates are mounted, provide blank, round canopy covers to match boxes.

2.3 Concrete Boxes

.1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

2.4 Conduit Boxes

.1 Cast FS or FD feraloy boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacle.

2.5 Fittings - General

.1 Bushing and connectors with nylon insulated throats.

.2 Knock-out fillers to prevent entry of debris.

.3 Conduit outlet bodies for conduit up to 32 mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

3. EXECUTION

3.1 Installation

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of Work.

.3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.4 Install all outlets flush and surface mounted as required for the installation.

.5 Surface mount above suspended ceilings, or in unfinished areas.

.6 Adjust position of outlets in finished masonry walls to suit course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes.

.7 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.8 Use plaster rings to correct depth. Use 30 mm on concrete block.

.9 Do not use sectional boxes.

.10 Provide boxes sized as required by the Canadian Electrical Code.

.11 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.12 Outlets installed in partition walls to be offset by a minimum of one stud space.

.13 Primary bushings in termination box for cable connection.

.14 Secondary bushings in termination box for bus duct connection.

.15 Control junction box.

.16 Stainless steel nameplate and connection diagram.

END OF SECTION

WIRING DEVICES

1. GENERAL

1.1 Work Included

.1 Provide and connect all wiring devices for the complete installation.

2. PRODUCTS

2.1 Manufacturer

.1 Wiring devices to be of one manufacture throughout project.

.2 Manufacturers shall be Arrow-Hart, Crouse-Hinds, Hubbell, or Pass & Seymour.

2.2 Devices

.1 The catalogue numbers shown below are for the particular Manufacturer's series and all necessary suffixes shall be added for the requirements as stated. All devices shall be Specification grade minimum and wherever possible shall be of the same manufacture.

.2 Devices to be brown with stainless steel coverplates in all but mechanical areas unless noted otherwise. Use galvanized steel coverplates in mechanical areas and for surface mounted devices.

2.3 Switches

.1 120-277 volt, 20 amp, single and double pole, three (3) and four (4) way: As Hubbell No. 1221, 1222, 1223 and 1224.

.2 For wet locations use the following switches: 20 A, 120 V single pole brown, side wired press-switch, as Hubbell No. 1281.

.3 Manually - operated general purpose AC switches shall have the following features:

.1 Terminal holes approved by AWG # 10 wire.

.2 Silver alloy contacts.

.3 Urea or melamine molding for parts subject to carbon tracking.

.4 Suitable for back and/or side wiring.

2.4 Receptacles

.1 Duplex 15 A, 120 V, 3 wire, brown, U-ground, as Hubbell No. 5252, with the following features:

.1 Brown urea molded housing.

.2 Suitable for # 10 AWG for back and side wiring.

.3 Eight (8) back wired entrances, four (4) side wiring screws.

.4 Break-off links for use as split receptacles.

.5 Triple wipe contacts and riveted grounding contacts.

.2 Duplex 15 ampere, 120 volt, 3 wire, brown, U-ground ground fault receptacle, as Hubbell No. GF-5261.

.3 Single 15 A, 120 V, 3 wire housekeeping receptacle with stainless steel plate engraved with Housekeeping, as Hubbell No. 5262.

.4 Receptacles located in the Ultraviolet (UV) Area and on the exterior of the building to be weatherproof construction.

.5 Welding outlets to be 60A 600 V; Crouse – Hinds CAT. No. DBR56742. Contractor to confirm on Site receptacle to match existing welding outlet.

.6 Provide coverplates for all wiring devices.

.7 Use sheet steel utility box cover for wiring devices installed in surface mounted utility boxes.

.8 Use stainless steel 1 mm thick coverplates on all wiring devices mounted in flush-mounted outlet boxes unless otherwise specified.

.9 Weatherproof double lift spring - loaded cast aluminum coverplates, complete with gaskets for single receptacles or switches.

.10 Weatherproof spring - loaded cast aluminum coverplates complete with gaskets for single receptacles or switches.

.11 Use gasketted DS cast covers on FS and FD type boxes.

3. EXECUTION

3.1 Installation

.1 Install single throw switches with handle in the "UP" position when switch closed.

.2 Install switches vertically in gang type outlet box when more than one switch is required in one location.

.3 Mount switches on the latch side of the doorway as close as possible to door frame unless otherwise indicated on Drawings.

.4 Install receptacles vertically in gang type outlet box when more than one (1) receptacle is required in one (1) location.

.5 Protect cover plate finish with paper or plastic film until all painting and other Work is finished, and then remove paper.

.6 Install suitable common coverplates where wiring devices are grouped. Do not distort plates by tightening screws excessively.

.7 Do not use coverplates meant for flush outlet boxes on surface mounted boxes.

.8 Wherever possible, mount equipment in a straight line at a uniform mounting height, coordinated with other equipment and materials.

.9 Mounting dimensions are to the centre of the devices. Final instructions on mounting heights shall be given by the Contract Administrator’s representative at the Site. The above shall be used as a guide, but shall be subject to final verification prior to installation.

END OF SECTION

WIRE AND BOX CONNECTORS 0-1000 V

1. GENERAL

1.1 Work Included

.1 Provide a complete system of wiring, making all connections necessary for the installation shown on Drawings.

1.2 Special Codes

.1 Install and rate power cables in accordance with the Canadian Electrical Code (CEC) 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 Manufacturer's Association of Canada (EEMAC) 1Y-2, Bushing Stud Connectors and Aluminum Adapters (1200 A Maximum Rating).

2. PRODUCTS

2.1 Materials

.1 Pressure type wire connectors: with current carrying parts same material as conductors sized to fit the conductors as required.

.2 Fixture type splicing connectors: with current carrying parts same material as conductors sized to fit the conductors 10 AWG or less.

.3 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for stranded copper conductors.

.2 Clamp for stranded copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper bar.

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 Thomas & Betts (T & B) non-insulated ring type compression lugs for terminating #10 AWG and smaller motor connections. Tape with rubber and scotchtape. Lugs to accept ten (10) - 32 x 3/8" machine bolts.

.3 Terminate conductors No. 8 AWG and larger with T & B Colour-Keyed compression connectors Series 54000 or on lugs provided with equipment.

.4 T & B "KOPR-SHIELD" compound Series CP8 on all terminations for compression connectors.

3. EXECUTION

3.1 Installation

.1 Remove insulation carefully from ends of conductors and:

.1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.

.2 Install mechanical pressure type connectors and tighten screws with appropriate compression tool recommended by Manufacturer. Installation shall meet secureness tests in accordance with CSA C22.2 No. 65.

.3 Install fixture type connectors and tighten. Replace insulating cap.

.4 Install bushing stud connectors in accordance with EEMAC 1Y-2.

3.2 Wire Connectors

.1 Select hand twist connectors for wire size and install tightly on conductors.

.2 Brush "KOPR-SHIELD" compound on terminations for compression connectors as recommended by the Manufacturer.

.3 Install compression connectors using methods and tools recommended by Manufacturer.

.4 Do not install stranded conductors under screw terminals unless compression lugs are installed.

END OF SECTION

CONNECTORS AND TERMINATIONS

1. GENERAL

1.1 Inspection

.1 Obtain inspection certificate of compliance covering high voltage stress coning from Contract Administrator and include it with as-built Drawings and maintenance manuals.

1.2 Product Data

.1 Submit Product data sheets in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Connectors and Terminations

.1 Copper long barrel compression connectors as required and sized for conductors.

.2 Contact aid for aluminum cables where applicable.

3. EXECUTION

3.1 Installation

.1 Install stress cones, terminations, and splices in accordance with Manufacturer's instructions.

.2 Bond and ground as required.

END OF SECTION

GROUNDING

1. GENERAL

1.1 Description

.1 Supply and Install a complete grounding system. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related Sections in the latest Canadian Electrical Code (CEC) and the local Electrical Inspection Branch.

.2 The extension to existing system, located at the existing Grit Building Main Distribution, to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed five (5) ohms.

.3 All ground conductors shall be run in conduit.

2. PRODUCTS

.1 Cables 2/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.

.2 All ground wires to be stranded copper TWH complete with a green jacket unless otherwise shown.

.3 Cable to pipe connectors to be made with Burndy GAR connectors.

3. EXECUTION

3.1 Grounding - General

.1 All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded via a ground wire.

.2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the CEC. The ground wire shall be terminated at each end with an appropriate grounding lug, which shall be connected to the equipment ground bus. Ground wire to be green TWH.

.3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the CEC.

.4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.5 All bolted connections must be accessible.

.6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.

.7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to Table 16, CEC.

.8 Expansion joints and telescoping Sections of raceways shall be bonded using jumper cables as per CEC.

.9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy Engineering Company's "Durium" or approved equal hardware.

.10 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.11 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.12 Conduit Installed buried in earth or Installed in or under grade floor slabs shall have separate ground wire Installed, whether the conduits are metal or not.

.13 Ground all utility services to the electrical system ground.

.14 Ground control cable shields at one end only. Ensure that shields are continuous over the entire circuit run.

END OF SECTION

OUTDOOR EQUIPMENT ENCLOSURES

1. GENERAL

1.1 Related Work

.1 Cast-in-Place Concrete - Installation of anchor devices, channel base sills, setting templates: Division 3

.2 Cast-in-Place Concrete - Concrete pad: Division 3

1.2 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Equipment

.1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish, Munsell Notation 7.5GY3.5/1.5, size as indicated.

.2 Entire enclosure capable of withstanding maximum impact force of 86 MN/m^2 area without rupture of material.

.3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.

.4 Enclosure equipped with hot dipped galvanized mounting rails 1.3 m adjustable horizontally and vertically to enable mounting of equipment at any location within housing. Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment. Holes in side panel flanges in 60 mm increments for vertical adjustment.

.5 Cover: tamperproof, bolt-on, domed to shed water.

.6 Door: minimum 1 m wide, hinged, three (3) point latching, with padlocking means.

.7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.

.8 Door interlocks: Provide interlocks as indicated.

.9 Enclosure construction such as to allow any configuration of single or ganged enclosures.

.10 Enclosure capable of being shipped in knocked down condition.

3. EXECUTION

3.1 Installation

.1 Assemble enclosure in accordance with Manufacturer's instructions and mount on concrete pad.

.2 Mount equipment in enclosure.

END OF SECTION

FASTENINGS AND SUPPORTS

1. GENERAL

1.1 Work Included

.1 Supply and Install all hangers, supports and inserts for the installation shown on the Drawings and specified herein, as necessary to fasten electrical equipment securely to the building structure.

2. PRODUCT

2.1 Framing and Support System

.1 Materials:

.1 Intermediate duty supporting structures shall employ P1000 Unistrut or equal together with the Manufacturers connecting components and fasteners for a complete system.

.2 Heavy duty supporting structures to be fabricated and welded from steel structural members and prime painted before installation.

.2 Finishes:

.1 Outdoors, wet locations: Hot dipped galvanized.

.2 Indoors, dry locations: Galvanized when available, prime painted if not available.

.3 Nuts, bolts, machine screws: Cadmium plated.

.3 Unistrut:

.1 Section P1000 or as required for load and span, with mounting screws, or approved. P1000 or equal is a minimum standard for supporting conduits 50 mm and larger.

2.2 Concrete and Masonry Anchors

.1 Materials: Hardened steel inserts, zinc plated for corrosion resistance. All anchor bolts must be galvanized.

.2 Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four (4).

.3 Manufacturer: Hilti (Canada) Limited or approved equal.

2.3 Non-Metallic Anchors

.1 Material: Plastic anchors for sheet metal screws.

.2 Manufacturer: Fischer.

2.4 Conduit Supports

.1 General: Malleable iron one-hole conduit straps where exposed to weather. Stamped steel two (2) hole straps indoors.

.2 Structural Steel: Crouse-Hinds "Wedgetite" supports or equivalent manufactured by Appleton.

.3 Masonry, concrete, stone, etc.: Anchors.

.4 Title: Toggle bolts.

.5 Metal studs, ceiling hangers, etc.: "Caddy-Clips".

.6 Unistrut: Unistrut conduit clamps.

2.5 Cable Supports and Clamps

.1 General: As per conduit supports, except that for single conductor cables, suitable non-ferrous, or approved stainless steel or aluminum clamps shall be used.

3. EXECUTION

3.1 General

.1 Do not cut or drill beams, joists or structural steel unless written permission of the Contract Administrator is obtained.

.2 Distance between conduit or cable supports not to exceed code requirements.

.3 Supports to be suitable for the real loads imposed by equipment.

.4 Supports to be securely fastened, free from vibration and excessive deflection or rotation. Maximum deflections are 4 mm over a 1 m span and 8 mm over a 2 m span.

.5 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with Manufacturer's installation recommendations.

.6 Provide conduit rack with 25% spare capacity for multiple runs.

.7 Provide channel support with fittings for vertical runs of conduit and cables.

3.2 Installation

.1 Secure equipment to solid masonry, tile and plaster surfaces with lead anchors or nylon shields.

.2 Secure equipment to poured concrete with expandable inserts.

.3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.4 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.5 Fasten exposed conduit or cables to building construction or support system using straps.

.1 One-hole malleable iron or steel straps to secure surface conduits and cables 50 mm and smaller.

.2 Two (2) hole steel straps for conduits and cables larger than 50 mm.

.3 Beam clamps to secure conduit to exposed steel Work.

.6 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support two (2) or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.7 Use plastic anchors for light loads only. Use metal anchors for all other loads.

.8 Shot driven pins may only be used with written approval of the Contract Administrator.

.9 Use round or pan head screws for fastening straps, boxes, etc.

.10 Do not support heavy loads from the bottom chord of open web steel joists.

.11 Support outlet boxes, junction boxes, panel tubs, etc., independent of conduits running to them. Support conduits within 600 mm of outlet boxes. Support surface mounted panel tubs with a minimum of four (4) 6 mm fasteners.

.12 For surface mounting of two (2) or more conduits use channels at 1.5 m of spacing.

.13 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

.14 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.

.15 Do not use wire lashing or perforated strap to support or secure raceways or cables.

.16 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.

END OF SECTION

DRY TYPE TRANSFORMERS

1. GENERAL

1.1 References

.1 Canadian Standards Association (CSA) C9, Dry-Type Transformers.

.2 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) GL1-3, Transformer and Reactor Bushings.

1.2 Source Quality Control

.1 Submit to Contract Administrator six (6) copies of standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9.

1.3 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include:

.1 Dimensioned Drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.

.2 Technical data:

.1 kVA rating.

.2 Primary and secondary voltages.

.3 Frequency.

.4 Three phase.

.5 Polarity or angular displacement.

.6 Full load efficiency.

.7 Regulation at unity pf.

.8 BIL.

.9 Insulation type.

.10 Sound rating.

.11 K rated.

1.4 Operation and Maintenance Data

.1 Provide operation and maintenance data for dry type transformers for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Operation and maintenance instructions to include:

.1 Tap changing.

.2 Recommended environmental conditions.

.3 Recommended periodic inspection and maintenance.

.4 Bushing replacement.

1.5 Storage

.1 Store transformers indoors in a dry location.

2. PRODUCTS

2.1 Materials

.1 Dry-type transformers: to CSA C9.

.2 Bushings: to EEMAC GL1-3.

2.2 Transformer Characteristics

.1 Type: ANN.

.2 Rating: Transformer Ultraviolet Test (UVT)-2: 4000 kVA, 3 phase, 60 Hz., K-13 rating.
Transformer UVT-3: 4000kVA, three (3) phase, 60 Hz., K-13 rated.
Transformer Large Scale Test (LST)-4: 1250kVA, three (3) phase, 60 Hz.
Transformer LST-5: 1250kVA, three (3) phase, 60Hz.
220^0C insulation system class, 150°C temperature rise.

.3 Impedance: 6.6% min.

.4 Primary winding: 5000 V, Delta, BIL 60 kV.

.5 Secondary winding UVT-2 and UVT-3: 277/480 V, Delta-Y, 3Ø, four (4) wire with neutral brought out and effectively grounded.

.6 Secondary winding LST-4 and LST-5: 600V, Delta-Y, 3Ø, three (3) wire.

.7 Sound rating: maximum 70 dB.

2.3 Enclosure

.1 Fabricated from sheet steel.

.2 Bolted removable panels for access to tap connections, enclosed terminals other accessories.

.3 Conductor entry:

.1 Primary entry for cables.

.2 Secondary entry for bus duct or cables as indicated.

.4 Designed for floor.

.5 Transformer UVT-2, UVT-3, LST-4, and LST-5: outdoor, ventilated, self cooled type, CSA 3R Enclosure.

.6 Pad Mounted Type UVT-2, UVT-3, LST-4, and LST-5:

.1 Primary cables enter through end wall of transformer adjacent to HV terminals.

.2 Secondary bus duct exit from transformer via bus duct transition on top of transformer above secondary terminals.

2.4 Voltage Taps

.1 Standard.

2.5 Tap Changer

.1 Bolted-link type.

2.6 Windings

.1 Primary and secondary coils:

.1 Copper.

.2 Vacuum cast epoxy.

.2 Coil and core assembly:

.1 Taps located at front of coils for accessibility.

.3 Sound level: not to exceed 70 dB.

2.7 Accessories

.1 Winding temperature detector relay and sensing elements with two (2) sets of SPDT contacts.

.2 Wiring and terminal box for protective devices.

.3 Digital type winding temperature indicator with alarm contacts.

.4 Grounding terminal: inside of enclosure.

2.8 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Equipment labels: nameplate size seven (7).

2.9 Acceptable Products:

- Hammond Manufacturing.
- Delta Transformers.
- Schneider Electric.
- Bemag Transformers.

3. EXECUTION

3.1 Installation

.1 Locate, Install and ground transformers in accordance with Manufacturer's instructions.

.2 Set and secure transformers in place, rigid plumb and square.

.3 Connect primary terminals to high voltage circuit.

.4 Connect secondary terminals to secondary feeder.

.5 Utilize flexible connections to transformers.

.6 Energize transformers and check secondary no-load voltage.

.7 Adjust primary taps as necessary to produce rated secondary voltage at no-load.

.8 Wire one set of contacts on winding temperature detector relay to indicate an alarm, wire second set of contacts to DCS alarm for high transformer temperature.

.9 Use torque wrench to adjust internal connections in accordance with Manufacturers' recommended values.

.10 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Energize transformers and apply incremental loads:

.1 0% for four (4) hours.

.2 10% for next one (1) hour.

.3 25% for next two (2) hours.

.4 50% for next three (3) hours.

.5 Full load.

.6 Once per hour and at each load change, check temperatures ambient, enclosure and winding.

END OF SECTION

66kV POWER TRANSFORMER LIQUID FILLED

1. DESCRIPTION

1.1 Description

.1 Provide transformer to transform primary 66 kV three (3) phase supply voltage to main secondary distribution voltage of 4160 V, three (3) phase, four (4) wire.

.2 The transformers shall be totally enclosed and shall be suitable for outdoors installation.

1.2 Codes and Standards

.1 The transformers are to be designed, manufactured and tested in accordance with the latest editions of the applicable Canadian Standards Association (CSA), Electrical and Electronic Manufacturer's Association of Canada (EEMAC), American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA) and International Electrotechnical Commission (IEC) Standards, and Manitoba Hydro Standard.

1.3 Related Work

.1	General Electrical Requirements:	Section 16010
.2	Transformer Pad:	Division 3
.3	Cast-In-Place Concrete:	Division 3

1.4 Source Quality Control

.1 The Contractor shall implement a quality assurance program in accordance with ISO 9001:2000.

1.5 Inspections and Factory Tests

.1 The transformer shall be inspected at each stage of manufacture in accordance with the Manufacturer's Quality Assurance Program and shall be completely assembled in the works. All deficiencies shall be corrected before shipment.

.2 Each transformer shall be completely factory tested and the results certified, proving the performance of the units to provide capacities as listed in these Specifications.

.3 The following tests shall be performed in accordance with CSA C88:

.1 Resistance measurements of all windings.

.2 Ratio test at rated connection and on all taps.

.3 Polarity and phase relation tests.

.4 Audible sound level tests.

.5 No-load loss at rated voltage and losses at 25%, 50%, 75%, and 100% load.

.6 Exciting current at rated voltage.

.7 Impedance and load loss test.

.8 Laboratory test of insulating liquid.

.9 Applied potential test.

.10 Induced potential test.

.11 Impulse tests: Primary 350 kV B.I.L. test; secondary 60 kV B.I.L. test.

.12 Pressure test.

.13 Dissipation factor test.

.14 Heat run, temperature rise tests on each transformer.

The above heat run tests and impulse tests to be witnessed by the Contract Administrator. Submit test certificate to the Contract Administrator.

.4 Carry out following insulation tests using megger with 20,000 megohm scale and resulting insulation resistance corrected to base of 20°C:

.1 High voltage to ground with secondary grounded for duration of test.

.2 Low voltage to ground with primary grounded for duration of test.

.3 High to low voltage.

.5 Inspect primary and secondary connections for tightness and for signs of overheating.

.6 Inspect and clean bushings and insulators.

.7 Check oil level and temperature indicators.

.8 Set transformer taps to rated voltage as specified.

.9 Inspect for oil leaks and excessive rusting.

.10 Inspect for oil level.

.11 Check for grounding and neutral continuity between primary and secondary circuits of transformer.

.12 Notify the Contract Administrator three (3) weeks in advance, in writing, of the time, date, and place of the tests. This test will be attended first by the Contract Administrator at the Contract

Administrator's expense. Any subsequent witness tests due to any reason whatsoever shall be at the expense of the equipment Manufacturer, but at the direction of the Contract Administrator.

.13 The Contract Administrator at his discretion may waive witness tests; such waiver shall be in writing and shall not imply any acceptance by the Contract Administrator nor limit the liability of the Manufacturer. A copy of the test results is to accompany the transformer when shipped.

1.6 Shop Drawings

.1 Submit Shop Drawings for Pad Mount 66 kV Transformer in accordance with Section 16010 – Electrical General Requirements and Division 1.

.2 Contractor shall submit the following information within thirty (30) days of receipt of order:

.1 Outline Drawings showing shipping and installed weights.

.2 Requirements for transformer pad; pad dimensions; openings for cable entry.

.3 Detail Drawings indicating compliance with this and other Specifications to determine the adequacy of engineering, Drawing presentation and information content.

.4 Transformer protection, including information on all instruments associated with the protection.

.5 Dimensioned positions of mounting devices.

.6 Dimensioned positions of terminations.

.7 Identified internal and external component layout on assembly Drawing.

.8 Insulating liquid capacity.

.9 Transformer grounding requirements, including information on transformer neutral grounding resistor.

.10 Coordination with the over-current protection devices with the HV fuses supplied by Manitoba Hydro.

.3 Submit Shop Drawings for the 66 kV Transformer Ground Grid in accordance with Specification Section 16010 – Electrical General Requirements and Division 1.

.1 Grounding Grid calculations and design for the transformer sealed by Professional Engineer registered in the Province of Manitoba.

.4 At completion of Work and prior to final acceptance, provide maintenance manuals for all items specified in this Section, in accordance with "Operations and Maintenance Manuals" in Division 1, including all test results.

1.7 Maintenance Data

.1 Provide maintenance data for liquid cooled transformers for incorporation into manual specified in Section 16010 – Electrical General Requirements.

.2 Include insulating liquid maintenance data.

1.8 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1.

.2 Provide Spare Parts as recommended by the Manufacturer.

1.9 Delivery and Storage

.1 Ship the transformer completely assembled and oil filled suitably protected from damage during transportation.

2. PRODUCTS

2.1 Manufacturer

.1 The transformer shall be manufactured by Partner Technologies Incorporated of Regina, Saskatchewan.

2.2 Ratings

.1 Type: FR3 liquid insulated, self-coded, fan cooling:

Phase	Three (3)
Cycles	60 Hz +- 1Hz
Capacity	5000 kVA,
Cooling	naturally cooled (ONAN)
Winding Temperature Rise	65°C measured by resistance
Insulation	Class H
Primary Voltage	66 kV delta
Secondary Voltage	4160/2400 volts wye
Primary Impulse Level	350 kV BIL
Secondary Impulse Level	60 kV BIL
Noise Level	65 dBA
No Load Watts Loss	10,000 watts maximum (CSA C802.3-01)
Max Impedance	8 %
Primary Taps Above Normal	2 – 2½% full capacity
Primary Taps Below Normal	2 – 2½% full capacity

Off circuit Tap selection shall be by manually operated with position indicator and suitable for padlocking in all tap positions.

2.3 Transformer Characteristics

.1 Transformers: To CSA C88.1.

.2 The transformer shall be liquid filled, naturally cooled (ONAN) of the sealed tank design, complete with integral radiators.

.3 Primary Voltage: 66,000 V, 60 Hz, Delta connected, three (3) phase.

.4 Secondary Voltage: 4160 V, wye connected, three (3) phase, four (4) wire, resistance grounded neutral.

.5 Capacity: 5000 kVA.

.6 Transformer windings shall be copper.

.7 Impedance: Not less than 6.5%; not more than 8%.

.8 No load losses not to exceed 10,000 W (CSA C802.3-01).

.9 Full load losses not to exceed 27,000 W (CSA C802.3-01).

.10 Provide the option for mounting of Intermediate Class 60kV MCOV arresters in the HV enclosure. The HV enclosure shall be mounted on the front and enclose the HV bushings. The doors shall be secured with penta headed bolts. When the doors are opened, a grounded metal heavy screen shall further restrict the entrance to the HV enclosure. The screens will be mechanically interlocked with the HV pole mounted disconnect switch. The screens can only be opened after the HV disconnect is locked in the open position.

.11 The secondary winding shall be wye connected. The neutral of the transformer shall be brought out and shall be suitable for resistance grounding installation. The LV bushings will be housed in a tamper proof enclosure on the side of the transformer.

.12 The low voltage terminals shall be ANSI 386 900 amp dead break dead front suitable for underground conductor cables.

2.4 Mounting

.1 The transformer shall be suitable for outdoor installation and all iron or steel fasteners shall be rust-proofed or galvanized in accordance with CSA standards.

.2 The base of the transformer shall be suitable for mounting on a flat slab type foundation and suitable for skidding or rolling in any direction.

2.5 Voltage Taps Off Circuit

.1 Four (4)-2.5% taps, two (2)-FCAN, two (2)-FCBN.

2.6 Tap Changer

.1 Off-circuit type with external operating handle with locking facilities and nameplate with markings to show tap voltages as actual voltages.

2.7 Sealed Tank

.1 Provide adequate capacity for the maximum increase in oil volume due to thermal expansion between extreme operating temperatures.

.2 The tank shall be fabricated from welded steel plate suitable to with stand full vacuum. All welding shall be in accordance with CSA W47.1 and CSA W57 standards.

2.8 Transformer Insulating Liquid

.1 To be fire retardant, non-corrosive, chemically degradable, thermally stable silicone, designed to operate with a 55/65°F rise insulation system.

2.9 Primary Bushings

.1 High voltage bushings suitable for cable connection will be IEC standard and shall be front wall mounted on a 45 degree angle suitable for connecting three (3) single conductor underground cables.

.2 Surround primary bushings with a termination box to permit connection of incoming cables. Provide compression-type connectors.

.3 Provide adequate space for stress cone termination of incoming power cables.

2.10 Secondary Bushings

.1 Low voltage neutral bushing suitable for cable connection and suitably rated, will be brought out to a live front bushing in the LV compartment.

.2 Surround secondary terminals with a terminal box.

.3 The secondary neutral is to be resistance grounded.

2.11 Neutral Grounding Resistor

.1 The neutral of the transformer shall be complete with a neutral grounding resistor, stainless steel type, 25 Amps continuous rated. Resistor element to be Nichrome, completely assembled in a hot-dipped galvanized outdoor enclosure.

.2 The neutral grounding resistor shall be provided with a ground current sensing device. The ground current sensing instrument and associated relay shall be Startco NGR Monitor c/w all necessary accessories or approved equal.

.3 The neutral grounding resistor shall also be provided with a resistor-open-circuit detection monitor.

2.12 Control Junction Box

.1 Provide control wiring junction box with terminal strip. Wire temperature and sudden pressure alarms and fan controls to terminal strip using rigid conduit and wire. Provide four (4) spare terminals on terminal strip. The control junction box is to be easily accessible from the floor level.

.2 Terminals and wire markers are to be as specified in Section 16153 – Connectors and Terminals.

2.13 Exterior Finish

.1 All exterior surfaces of the transformer shall be grit blasted clean, all foreign materials to be removed prior to powder paint application. The exterior shall be powder painted or coated and finished Sea Foam Green consisting of one (1) coat zinc primer and one (1) final powder coat minimum dry.

.2 Provide four (4) cans of spray paint for touch-up after installation.

2.14 Identification

.1 Provide lamacoid nameplates with 12 mm letters per Section 16010 – Electrical General Requirements.

.2 City's Equipment Reference Label: Size seven (7).

2.15 Accessories

.1 The transformer shall be provided with all standard accessories as required by CSA Standard CAN3-C88. Items required are:

.2 Filter press connection.

.3 Liquid Celsius temperature measuring devices, maximum indicating type, dial size 100 mm with one set of contacts.

.4 Liquid level gauge with two (2) sets of contacts.

.5 Pressure-vacuum gauge with two (2) sets of contacts.

.6 Winding Celsius temperature detector relay and sensing elements with two (2) sets of contacts.

.7 Ground current monitoring device to be connected to transformer circuit interrupter.

.8 Neutral Grounding resistor open circuit monitoring switch with two (2) sets of contacts.

.9 Wiring and terminal box for protective devices.

.10 Top non-flammable insulating liquid sampling device.

.11 Bi-directional skid base.

.12 Liquid drain valve, one (1) inch bronze with sampling valve.

.13 Sudden pressure relay with alarm contacts.

.14 Qualitrol 208 pressure relief device with an operating pressure of eight (8) PSI, self re-sealing complete with hood deflector.

.15 Anodized aluminum nameplate and connection diagram.

.16 Ground pads, two (2) stainless steel complete with two (2) taped holes NEMA spaced.

.17 Ground studs and lugs.

.18 Bolted sealed cover.

.19 Four (4) heavy duty lifting lugs suitable for securing the transformer for transportation.

2.16 Grounding Grid

.1 Design, provide and Install all necessary Products to make a complete Grounding Grid System for the 66kV high voltage pad mount transformer and associated equipment. Ground grid shall be designed to IEEE 80 and IEEE Guide for Safety in AC Substation Grounding.

.2 Conduct a soil resistivity test on Site and include the soil resistivity value in the Step-and-Touch voltage calculation and in the design of the Grounding Grid. The calculations and the design shall be signed and sealed by a Professional Engineer registered in Manitoba.

.3 The Grounding Grid shall consist of ground rods driven to permanent moisture and interconnected by a grid system of bare, soft annealed copper conductors.

.4 The Grounding Grid around the transformer shall be designed in accordance with the Step-and-Touch voltage limits specified in Canadian Electrical Code Table 52 and in accordance with Step-and-Touch voltage calculations specified in IEEE Standard 80 including the following:

.1 Clearing time – the default is 60 cycles unless a faster time can be demonstrated.

.2 Soil model shall consist of at least three (3) layers.

.1 Top layer – 25 mm with a resistivity of five (5) ohm-m.*

.2 Middle layer – 1.5 m frozen ground.

.3 Bottom layer – natural soil.

*If 150 mm of 19 mm crushed rock can be maintained, the top layer becomes 150 mm with a soil resistivity of 3000 ohm-m.

.5 Submit the Step-and-Touch voltage calculations signed and sealed by a Professional Engineer registered in Manitoba and the Grounding Grid design to the Contract Administrator.

3. EXECUTION

3.1 Installation

.1 Install Grounding Grid around the transformer as designed, and specified in previous paragraphs of this Section.

.2 Install transformers only after other Work in area is completed and in accordance with Manufacturer's instructions.

.3 Install transformer as indicated on the Drawings and in accordance with the Manufacturer's recommendations.

.4 Mount the transformer on concrete pad; ensure that the pads are true and level. Mount the transformer assembly on the isolators as recommended by the Manufacturer. Ensure concrete pad is fully cured for 28 days before installation of transformer

.5 Use spreader bars on slings when lifting transformers into place.

.6 Set and secure transformer in place rigid, plumb, and square.

.7 Ensure internal connections are mechanically tight.

.8 Make connections.

.9 Connect transformer Neutral terminal to system ground through supplied neutral grounding resistor.

.10 Set taps to produce rated secondary voltage at no-load.

.11 Wire one (1) set contacts on liquid temperature measuring device, liquid level gauge, gas detector relay, winding temperature detector relay, to a terminal box and DCS System; wire second set contacts to trip transformer circuit interrupter.

.12 Connect the high temperature contact to alarm circuit as indicated and to trip transformer circuit interrupter.

.13 Connect Ground current monitoring device to the transformer circuit interrupter.

.14 Before energization, keep transformers or storage room enclosure above 10°C, ambient.

3.2 Testing

.1 After the transformers have been set in place, prior the energizing, verify in writing that the transformers have been installed and tested in accordance with recommended practice and are suitable for energizing and use.

.2 Without limiting the foregoing, the Work shall, as a minimum, include the following:

.1 Prior to connecting, the Electrical Contractor is to inspect visually and conduct the following tests:

.1 Megger insulation and correct reading to 20°C base. Megger high voltage to ground with the secondary grounded for the duration of the test. Megger low voltage to ground with the primary grounded for the duration of the test.

.2 Perform electrical centres test on high voltage off-load tap changer switch.

.3 Sample transformer insulating liquid laboratory analysis to be carried out as follows:

.1 Dielectric breakdown.

.2 Neutralization number.

.3 Colour.

.4 Interfacial tension.

.5 Specific gravity.

.4 Leak test piping.

.5 Perform ratio test for all transformer gap positions.

.6 Verify that shipping braces and shipping shims have been removed.

.2 After connection of line, load, control, and alarm wiring, but prior to energizing, the calibration and verification firm is to inspect the installation and confirm the following:

.1 That the transformer has been properly cleaned, is dry and free of foreign materials and contaminants, and otherwise is suited for energizing.

.2 That all bus and connector bolts have been installed, tightened, torqued properly, and uninsulated surfaces of connectors and buses have been taped.

.3 That transformer taps have been set to provide secondary voltage required.

.4 That all insulators are in perfect condition, without cracks, chips, or surface contaminants.

.5 That core, coil, terminal boards, tap changers, bushings and all insulated surfaces have not been damaged.

.6 That the forced cooling fans are functioning and that the power supply circuits to the fans have been properly connected and protected.

.7 That all alarm and indicating devices are operating correctly, and are properly connected either internally or externally from the terminal of the instrument to the external system, including the following:

.1 Liquid level and pressure.

.2 Liquid temperature, with hi and hi-hi contacts connected to the building control computer.

.3 Sudden pressure is unblocked and wired to trip the primary circuit breaker.

.3 Any other tests or inspections deemed necessary or appropriate by the Manufacturer.

END OF SECTION

PRIMARY LIGHTNING ARRESTERS

1. GENERAL

1.1 References

.1 Gapless Metal Oxide Surge Arresters for Alternating Current Systems. – Canadian Standards Association (CAN/CSA) - C233.1.

.2 American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE) C62.36, Surge Protectors Used in Low Voltage Data Communications and Signaling Circuits, Standard Test Methods. - ANSI/IEEE C62.36.

1.2 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Materials

.1 Arrester component parts to CAN/CSA C233.1 and ANSI/IEEE C62.36.

.2 Arrester characteristics.

.1 Intermediate distribution arrester.

.2 System highest voltage line to line 66 kV.

.3 Maximum continuous operating voltage (MCOB): 66 kV.

.4 Indoor type.

.5 Housing: Polymer.

3. EXECUTION

3.1 General

.1 Cadweld or approved compression cable connections shall be acceptable.

.2 All conductor runs shall be as short and straight as possible and shall be perpendicular or parallel to building lines/planes.

.3 Install ground rods and associated items as per Section 16450 - Grounding Secondary.

3.2 Arresters

.1 Connect line terminals to phase conductors.

.2 From arrester ground terminal run min. No. 4, bare, copper ground wire down pole to ground rod.

.3 From arrester ground terminal run shortest possible min. No. 4 RWU90 conductor to secondary neutral of transformer.

.4 Install primary arrestors at customer service entrance pole as indicated in Section 16121 – Overhead Conductors 66 kV.

END OF SECTION

METAL-CLAD SWITCHGEAR ASSEMBLY TO 15 KV

1. GENERAL

1.1 Related Work

.1 Installation of anchor devices, setting templates: Division 3

1.2 References

.1 Canadian Standards Association (CAN/CSA)-C22.2 No. 31, Switchgear Assemblies.

.2 CAN/CSA-G40.21, Structural Quality Steels.

.3 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) G1-1, Indoor Switch and Bus Insulators.

.4 EEMAC G8-3.2, Metal-Clad Switchgear Assemblies.

1.3 Description of System

.1 Provide free-standing, self-supporting, pre-engineered indoor metal clad power switchgear, shop fabricated, shipped to Site, complete with all fittings for field erection.

.2 Primary switchgear assembly to include:

.1 Enclosure.

.2 Circuit Breakers.

.3 Busbar.

.4 Meters.

.5 Power fuses.

.6 Instrument transformers.

.7 Control wiring and accessory devices.

1.4 Source Quality Control

.1 Provide Manufacturer's type test certificates indicating switchgear cubicles and components tested as integrated assembly.

.2 Submit seven (7) copies of Production test results to Contract Administrator before equipment is shipped from factory.

1.5 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements and Division 1.

.2 Indicate:

.1 Floor anchoring method and dimensioned foundation Drawings.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned cable termination height.

.4 Dimensioned position and size of bus bars and details of provision for extension.

.5 Dimensioned positions of main connections, including air clearances and support insulators.

.6 Layout of internal and front panel components suitably identified.

.7 Time current characteristics curves of protection devices.

1.6 Maintenance Data

.1 Provide maintenance data for primary switchgear assembly for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Include six (6) copies of maintenance data for complete switchgear assembly including components.

1.7 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1.

.2 Include:

.1 One (1) set power fuses of each type installed.

1.8 Delivery and Storage

.1 Ship and store switchgear assembly in upright position.

.2 Store in weather protected, warm, and dry enclosure.

.3 Keep doors locked and protect instruments from damage and dust.

.4 Ship channel base sills, anchoring devices in advance of switchgear.

.5 Equipment shall be handled and stored in accordance with Manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

1.9 Protection Co-ordination

.1 Co-ordinate time-current characteristics of protective relays.

1.10 Requirements of Supply Authority

.1 Submit Shop Drawings to supply authority and obtain certification that equipment meets their requirements, before submission of Drawings to Contract Administrator.

2. PRODUCTS

2.1 Materials

.1 Switchgear assembly: To CAN/CSA C22.2 No.31, EEMAC G8-3.3.

.2 Steel for cubicles: To CAN/CSA G40.21.

.3 Insulators: To EEMAC G1-1.

2.2 Primary Switchgear

.1 Primary switchgear: Indoor 5 kV, 1200 A, three (3) phase, three (3) wire, short circuit capacity 63kA, BIL 60 kV.

2.3 Primary Enclosure

.1 Primary enclosure: Metal clad free standing, floor mounted, dead front, indoor CSA Enclosure one (1) cubicle unit. Constructed from rolled flat steel sheets 11 gauge thick.

.2 Ventilating louvres: Vermin and insect proof.

.3 Use non-corrosive bolts and hardware.

.4 Access from front and back.

.5 100 mm steel channel sills for base mounting.

.6 The switchgear assembly shall be individual vertical Sections housing various combinations of circuit breakers and auxiliaries bolted to a form a rigid metal clad switchgear assembly. Metal sides shall provide grounded barriers between adjacent structures and solid removable barriers shall isolate the major primary Sections of each circuit. Two (2) rear covers shall be provided for each vertical Section for circuit isolation an ease of handling.

.7 Hinge doors on same side.

.8 Provide gaskets for all removable covers.

.9 Provision for future extension on both sides of cubicle unit.

.10 Each cubical Section shall have indoors.

.11 Metal pocket c/w weatherproof envelope and one (1) set of Drawings and diagram prints on inside surface of door.

2.4 Bus Bars

.1 Three (3) phase, insulated busbars, continuous current rating 1200A extending full width of multi-cubicle switchboard with suitably supported on insulators.

.2 The main bus shall be copper and have fluidized epoxy flame-retardant and track-resistant insulation.

.3 Bus supports between units shall be flame-retardant, track-resistant, glass polyester for five (5) and 15 kV class.

.4 Switchgear shall be constructed so that all buses, bus supports and connections shall withstand stress that would be produced by current equal to the momentary rating of the circuit breaker.

.5 Insulated copper main bus shall be provided and have provision for future extension.

.6 Bus joints shall be plated, bolted and insulated with easily installed boots.

.7 Bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers.

.8 Temperature rise of the bus and connections shall be in accordance with American National Standards Institute (ANSI) standards and documented by design.

.9 A copper ground bus shall extend the total length of the switchgear.

.10 Silver surfaced joints, secured with non-corrosive bolts and washers, tightened with torque wrench in accordance with Manufacturer's recommendations.

.11 Identify phases of busbars by suitable marking.

.12 Busbar connectors when switchgear shipped in more than one (1) section.

2.5 Grounding

.1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.

.2 Lugs at each end for size No. 3/0 AWG grounding cable.

.3 Bond non-current carrying parts, including switchgear framework, enclosure and bases to ground.

2.6 Circuit Breakers

.1 Refer to Section 16350 – Medium Voltage Vacuum Circuit Breakers.

2.7 Interlocks

.1 Refer to Section 16359 – Interlocks.

2.8 Instrument Transformers

.1 Refer to Section 16432 – Instrument Transformers.

2.9 Miscellaneous Hardware

.1 Provide miscellaneous hardware as required, compatible with other components. Provide warning signs as required by Electric Utility and Inspection Authorities.

2.10 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.

.2 Cubicle exteriors: Gray.

.3 Cubicle interiors: White.

.4 Supply two (2) spray cans touch up paint.

2.11 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Nameplates:

.1 Switchgear designation: Label - white plate, black letters, size seven (7), engraved.

.2 Individual cubicle designations: Labels - white plate, black letters, size five (5), engraved.

2.12 Warning Signs

.1 Provide warning signs in accordance with Section 16010- Electrical General Requirements.

3. EXECUTION

3.1 Installation

.1 Set and secure substation structure in place rigid, plumb and square and as indicated.

.2 When switchgear arrives on Site, connect strip heaters to temporary power supply and switch on if night time temperatures are below 4°C.

.3 Install switchgear on pad as shown on Drawings and switchgear erection Drawings and instructions, using experienced tradesmen.

.4 Inspect exterior and spot-paint where necessary.

.5 Make field connections in accordance with Manufacturer’s recommendations.

.6 Connect ground bus to building system ground.

.7 Render entire assembly rodent and insect proof by means of plates, screens, and grouting.

.8 Ensure fixed housing into which circuit breaker moving carriage enters, is plumb.

.9 Check factory made connections for mechanical security and electrical continuity.

.10 Check relay settings against Shop Drawings.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Checkout.

.1 Checkout shall be performed by a technical representative of the switchgear Manufacturer or a suitably qualified person and a written report shall be submitted. The following shall be considered as a guide and shall be adjusted to suit equipment requirements.

.2 Clean, vacuum and inspect interiors of all cubicles.

.3 Clean and check main and arcing contacts.

.4 Check switches and fuseholders for freedom of movement and contact engagement.

.5 Check interlocks for proper operation and safety procedure.

.6 Inspect for proper grounding.

.7 Inspect bus and support insulators, clean and polish porcelain.

.8 Check and tighten all hardware and connections.

.9 Lubricate according to Manufacturers instructions.

.10 Meguro and hi-pot test phase to phase and phase to ground using a minimum of 1000 volts DC. If values not satisfactory, perform the required remedial work and repeat tests until readings are acceptable to the Contract Administrator.

.11 Check main fuses for proper sizing, check for adequate spare refill units.

.12 Check phase rotation of each feeder.

.13 Operate circuit breaker closing and tripping mechanisms, to verify correct functioning.

.14 Place primary switchgear in service and check ammeter, voltmeter, wattmeter, and power factor meter readings to ensure proper functioning of instruments and satisfactory phase balance and power factor of load.

.15 Perform step and touch potential and station ground tests to comply with Canadian Electrical Code requirements.

END OF SECTION

MEDIUM VOLTAGE VACUUM CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Circuit Breakers

.1 Indoor vacuum circuit breaker, three (3) pole, single break, power operated, draw out breaker element, sized as indicated.

.2 Circuit breaker shall be operated by a motor-charged spring stored energy mechanism. The spring may be charged manually in an emergency or during maintenance procedures.

.3 Circuit breakers shall have three (3) vacuum interrupter assemblies that are separately mounted, self- aligning pole unit on glass polyester supports for 5 kV insulators. The breaker front panel shall be removable when the compartment door is open for ease of inspection and maintenance of mechanism.

.4 The primary disconnect contacts shall be silver-plated copper.

.5 The current transfer from the vacuum interrupter moving stem to the breaker contactor shall be a non-sliding design.

.6 Interlocks shall be provided to prevent closing of the breaker between operating and test position, to trip breaker upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the house between and including the operation and test positions.

.7 Breaker shall be electrically operated by 120 V AC close and AC capacitor trip.

.8 Breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position.

.9 Control voltage shall be derived from within equipment.

2.2 Rating – Switch Gear, Switch and Circuit Breaker

.1 The 5 kV switchgear assembly rating shall be as follows:

.1	Maximum voltage.	4.76 kV
.2	Basic impulse level.	60 kV
.3	Available system three (3) phase short circuit current to be confirmed with coordination study.	63 kA
.4	Nominal system voltage.	4.16 kV 3 phase 3 wire solid ground
.5	Main cross bus continuous current rating.	1200 A

.2 The 5 kV breaker rating shall be as follows:

.1	Circuit breaker nominal three (3) phase MVA class.	350

.2 Short circuit current to be confirmed in short circuit coordination study.

2.3 Construction

.1 The switchgear assembly shall consist of deadfront, completely metal-clad vertical section with drawout vacuum circuit breaker.

2.4 Bus

.1 All buses shall be silver plated copper.

.2 Ground bus conductor shall be silver plated copper.

.3 Bus supports to be high strength and high creep, finned supports providing a minimum of 356 mm of creep between phase and ground.

2.5 Trip Unit

.1 Microprocessor three phase protection relay.

.2 Relay for phase time over current, instantaneous overcurrent and ground fault protection, American National Standards Institute (ANSI) 50/51, 50/51G shall be incorporated into a single device similar to a Cutler-Hammer Digitrip DT 3010.

2.6 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

.2 Label Size: Seven (7).

2.7 Approved Manufacturer

.1 Cutler-Hammer.

.2 Schnieder.

.3 Siemens.

3. EXECUTION

3.1 Factory Testing

.1 Standard factory tests shall be performed on circuit breaker elements in accordance with the latest version of ANSI, Canadian Standards Association (CSA) and National Electrical Manufacturers Association (NEMA) standards.

3.2 Field Quality Control

.1 Provide services of a quality factory-trained Manufacturer's Representative to assist the Contractor in installation and start-up of equipment specified under this Section.

.2 Perform test in accordance with Section 16980 – Testing, Adjusting and Balancing of Electrical Equipment and Systems.

3.3 Installation

.1 Set and secure cubicle in place, rigid, plumb and square, on channel base.

.2 Interconnect cubicles to adjacent equipment as indicated.

.3 Check factory-made connectors for mechanical security and electrical continuity.

.4 After finishing Work, remove foreign material, including dust, before energizing substation.

END OF SECTION

INTERLOCK SYSTEMS

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Interlock Systems

.1 Kirk key interlocks, Type F for load interrupter switch and Type D for switchgear cubicle door to prevent:

.1 Opening cubicle door for access to fuses while load interrupter is in closed position.

.2 Closing load interrupter while cubicle door is open.

.2 Key interlocks mounted in switchgear so that interlocks cannot be removed when operating switch or breaker is in closed position.

2.2 Manufacturer

.1 Kirk Interlocks.

3. EXECUTION

.1 Install interlocks on switch or breakers cubicle as indicated on Drawings.

END OF SECTION

OUTDOOR LOAD BREAK SWITCHES AND FUSES

1. GENERAL

1.1 References

.1 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) G1-1, Indoor and Outdoor Switch and Bus Insulators.

.2 National Electrical Manufacturers Association (NEMA) SG2, High-Voltage Fuses.

.3 American National Standards Institute (ANSI) C37.26, Power Fuses and Fuse Disconnecting Switches.

1.2 Shop Drawings and Product Data

.1 Submit shop drawings and product data in accordance with Section 16010 - Electrical General Requirements and Division 1.

.2 Indicate:

.1 Load break mechanism.

.2 Switching type.

.3 Mounting design.

.4 Fuse holder mechanism.

.5 Gang operating mechanism.

.6 Load rating.

1.3 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1.

2. PRODUCTS

2.1 Materials

.1 Fuses: To NEMA SG2 and ANSI C37.46.

.2 Insulators: To EEMAC G1-1.

2.2 Light Load Air Break Switches

.1 Vertically mounted, Horizontal break, rotating insulator, gang operated, single throw, three (3) pole.

.2 Rating: 200A, 66 kV.

.1 Momentary rms asymmetrical.

.3 Insulators: Post type.

.4 Universal mounting base for each pole designed for wood mounting.

.5 Arc horns: Galvanized steel to permit switch opening and closing under light load, magnetizing or charging currents.

.6 Bearings: Silicone grease lubricated for life.

.7 Interphase mechanism assembly:

.1 Operated from center pole end.

.2 Outside poles connected to center pole through end yoke assemblies, pipe turnbuckles and universal ball and yoke assembly to permit switch operation with up to 15° misalignment of pole bases.

.3 Bearings and moving joints on each pole and interphase mechanism positively sealed by silicone cord rings.

.8 Manual operating mechanism with:

.1 One (1) offset bearing.

.2 Pipe shaft: to suit pole mounted switch height.

.3 Pipe guides.

.4 Pipe couplings.

.5 Position indicator.

.6 Foot bearing.

.7 Operating handle with padlock.

2.3 Full Load Air Break Switches

.1 Vertical mounted, side break, gang operated, single throw, three (3) pole.

.2 Rating 200 A, 66 kV.

.1 Momentary rms asymmetrical.

.3 Insulators: Three (3) per pole, standard station post type.

.4 Contacts.

.1 Copper tungsten alloy multi-contact fixed contacts.

.2 Copper tungsten alloy spring loaded multi-contact switch blade contacts.

.5 Interrupter unit to permit opening and closing under rated full load currents consists of:

.1 Mechanism actuated by levers for operating contacts.

.2 Bolted to fixed contact assembly of switch.

.3 Shunt contact bolted to switch blade actuates interrupter unit when blade is moved to open or closed position.

.6 Switch base: 5 mm formed channel galvanized steel drilled for universal mounting on wood.

.7 Interphase mechanism assembly.

.1 Operated from end.

.2 Poles interconnected by articulated pipe assembly to allow for minor misalignment.

.8 Manual operating mechanism with:

.1 Two (2) offset bearings.

.2 Pipe Shaft: 1 m long.

.3 Pipe guides.

.4 Pipe couplings.

.5 Position indicator.

.6 Foot bearing.

.7 Operating handle with padlock.

2.4 Primary Fuses

.1 Disconnect vertical 180° opening type.

.2 Voltage rating: 66 kV.

.3 Continuous current rating: As recommended by Manitoba Hydro.

.4 Three (3) phase symmetrical short circuit ratings.

.1 As Recommended by Manitoba Hydro.

.5 Refill unit consisting of:

.1 Fusible element: silver.

.2 Arcing rods: Main rod copper, silver clad, auxiliary rod stainless steel.

.3 Solid material arc-extinguishing medium contained in filament wound glass-epoxy tube.

2.5 Ground Grid

.1 Design, provide and install a Grounding Grid around the pole mounted break switch.

.2 Conduct a soil resistivity test on site and include the soil resistivity value in the Step-and-Touch voltage calculation and in the design of the Grounding Grid. The calculations and the design shall be signed and sealed by a Professional Engineer registered in Manitoba.

.3 The Grounding Grid shall consist of ground rods driven to permanent moisture and interconnected by a grid system of bare, soft annealed copper conductors.

.4 The Grounding Grid around the pole mounted break switch shall be designed in accordance with the Step-and-Touch voltage limits specified in Canadian Electrical Code (CEC) Table 52 and in accordance with Step-and-Touch voltage calculations specified in Institute of Electrical and Electronic Engineers (IEEE) Standard 80.

.5 Submit the Step-and-Touch voltage calculations signed and sealed by a Professional Engineer registered in Manitoba and the Grounding Grid design to the Contract Administrator.

3. EXECUTION

3.1 Installation

.1 Install in accordance with Manufacturers instructions.

.2 Connect switch terminals as shown on drawings.

.3 Locate, mount and connect fuses.

END OF SECTION

COORDINATION AND SHORT CIRCUIT STUDY

1. GENERAL

1.1 Description

.1 Provide a coordination/protective study and short circuit study of all equipment specified herein and submit for review.

.2 Include the following:

.1 5 kV cable thermal damage curves (8 KV Rated).

.2 5 kV vacuum breakers, 480 and 600 V air circuit breaker overcurrent, overload, and ground fault devices.

.3 277/480, 600 and 120/208V panelboards, and switchgear, connecting feeder cables and bus duct.

.4 5 kV, 277/480 and 600 V transformer damage curves, magnetizing currents for all transformers 150 kVA and larger.

.5 Locked rotor currents, acceleration times and damage curves for motors 75 kW and larger.

.6 Any additional data necessary for successful completion of the coordination and short circuit study.

.7 Study to be inclusive for new distribution equipment at the Ultraviolet (UV) Building, new 5 kV breaker at Grit Building Distribution and pole mounted switch and fuses (66 kV) at service to new facility.

.3 Data shall clearly state the operating time in cycles of each breaker and indicate whether the time current curves for relays are inclusive of breaker tripping times or otherwise.

.4 Prepare a summation chart showing all ratings and settings with easy reference to the appropriate curve.

.5 Symmetrical and asymmetrical fault current calculations shall be submitted to verify the correct choice of the protective elements of the system.

.6 Prepare a systems single line diagram on which the resultant short circuit values, device numbers and equipment ratings are shown.

.7 Include a list of recommended settings for each relay.

COORDINATION AND SHORT CIRCUIT STUDY

1.2 Related Work

.1	Dry Type Transformers:	Section 16322
.2	66kV Power Transformer Liquid filled:	Section 16330
.3	Metal-Clad Switchgear Assembly to 15kV:	Section 16346
.4	Medium Voltage Vacuum Circuit Breakers:	Section 16350
.5	Outdoor Load Break Switches and Fuses:	Section 16361
.6	Secondary Switchgear:	Section 16426
.7	Dry Type Transformers up to 600 V Primary:	Section 16461

1.3 Qualifications

.1 This study shall be provided by the supplier of the main switchgear.

.2 This study shall be performed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

1.4 Submittals

.1 Submit the complete study for review prior to carrying out calibration and verification.

.2 Submit typed results of coordination and short circuit study in maintenance manuals.

2. PRODUCTS

2.1 Tripping Devices

.1 Relay style, CT ratios and fuse sizes have been selected on a preliminary basis for design purposes. Final selection shall be based on the results of this study and shall be included at no extra cost.

3. EXECUTION

3.1 Data

.1 Provide the main switchboard supplier with all relevant data for equipment not provided by that supplier.

END OF SECTION

SECONDARY LIGHTNING ARRESTERS

1. GENERAL

1.1 Shop Drawings and Product Data

.1 Submit Shop Drawings and Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Equipment

.1 Arrester component parts: To Canadian Standards Association (CSA) C233.

.2 Arrester characteristics:

.1 System voltage: 600V

.2 Rated voltage of arrester: 550 V.

.3 Indoor type.

3. EXECUTION

3.1 Installation

.1 Install arresters and connect to secondary bus and ground bus.

END OF SECTION

SECONDARY SWITCHGEAR

1. GENERAL

1.1 References

.1 Electrical and Electronic Manufacturer's Association of Canada (EEMAC) G8-3.3, Metal-Enclosed Interrupter Switchgear Assemblies.

1.2 Shop Drawings Product Data

.1 Submit Shop Drawings and Product data in accordance with Section 16010 - Electrical General Requirements and Division 1.

.2 Indicate on Shop Drawings:

.1 Floor anchoring method and foundation template.

.2 Dimensioned cable entry and exit locations.

.3 Dimensioned position and size of bus.

.4 Overall length, height and depth of complete switchgear.

.5 Dimensioned layout of internal and front panel mounted components.

.3 Indicate on Product data:

.1 Time-current characteristic curves for air circuit breakers.

1.3 Maintenance Data

.1 Provide maintenance data for secondary switchgear for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Six (6) copies maintenance data for complete switchgear assembly including components.

1.4 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 1.

1.5 Storage

.1 Store switchgear on Site in protected, dry location. Cover with plastic to keep off dust and contaminants.

.2 Provide energized strip heater in each cell to maintain dry condition during storage.

2. PRODUCTS

2.1 Materials

.1 Switchgear assembly: to EEMAC G8-3.3.

2.2 Rating

.1 Ultraviolet (UV) secondary switchgear: indoor, 277/480 V, 5000 A, three (3) phase, four (4) wire, 60 Hz, minimum short circuit capacity 65 kA (rms symmetrical). Interrupting capacity rating to suit Coordination Study requirements.

.2 UV Influent Pump Station switchgear: indoor 600 V, 1600 A, three (3) phase, three (3) wire, 60 Hz, minimum short circuit capacity 65 kA (rms symmetrical). Interrupting capacity rating to suit Coordination Study requirements.

2.3 Secondary Switchgear

.1 Secondary switchgear:

.1 UV Distribution: 277/480 V, 5000A, three (3) phase, four (4) wire.

.2 UV Influent Pump Distribution: 600V, 1600A three (3) phase, three (3) wire.

.2 Secondary switchgears to consist of the following equipment:

.1 Metal enclosed drawout switchgear. Size of equipment shall be as indicated on the Drawings.

.2 TVSS surge protection – bus connect.

.3 Main breaker with digital overcorrect protection. Size of main breakers shall be as indicated on the Drawings.

.3 Acceptable Manufacturers

.1 Eaton Cutler-Hammer Magnum DS series.

.2 Schneider Electric.

.3 Seimens Electric.

2.4 Enclosure

.1 Main incoming Section to contain:

.1 Power air circuit breaker sized as indicated.

.2 Microprocessor based trip unit including:

.1 Long Time Delay.

.2 Short Time Delay.

.3 Instantaneous Time Delay.

.4 Ground Fault Protection.

.3 Microprocessor based digital monitoring and protective devices. Refer to Section 16435.

.2 Distribution Sections to contain:

.1 Draw out air circuit breakers, sized as indicated.

.2 Copper bus, from main Section to distribution Sections including vertical bussing.

.3 Microprocessor based tripping device.

.3 Blanked off space for future units.

.4 Metal enclosed, free standing, floor mounted, dead front, indoor Canadian Standards Association (CSA) Enclosure one (1) cubicle unit.

.5 Ventilating louvres: vermin, insect proof.

.6 Access from front and rear.

.7 Steel channel sills for base mounting in single length common to multi-cubicle switchboard.

.8 Provide bus duct entry hardware to accept the bus ducts for the incoming service feeders to each switchboard.

.9 Provide a breaker trolley truck for removal and installation of circuit breakers.

.10 Provide suitable quantity and size of lugs for cables as indicated on the Drawings.

2.5 Busbars

.1 UV Distribution: Three phase, 200% capacity neutral bare busbars, continuous current rating 5000A self-cooled, extending full width of cubicle, suitably supported on insulators.

.2 UV Influent Pump Distribution: Three phase bare ground busbars, continuous current rating of 1600A self cooling, extending full with of cubicle, supported on insulators.

.3 Main connections between bus and major switching components to have continuous current rating to match major switching components.

.4 Busbars and main connections: 99.30% conductivity copper.

.5 Silver surfaced joints, secured with non-corrosive bolts and Belleville washers.

.6 Identify phases of busbars by suitable marking.

.7 Busbar connectors, when switchboard shipped in more than one (1) Section.

2.6 Grounding

.1 Copper ground bus not smaller than 50 x 6 mm extending full width of multi-cubicle switchboard and situated at bottom.

.2 Lugs at each end for size of grounding cable required.

2.7 Power Circuit Breaker

.1 Power circuit breakers: 600 V class, continuous current rating, and trip rating as indicated on Drawings, interrupting rating 65 kA. All breakers shall be 100%.

.2 Drawout type breaker with dual magnetic direct-acting trips on each pole providing adjustable over-current and instantaneous protection:

.1 Delayed direct-acting trips with coil rating calibration range, for overcurrent conditions from 80% to 160% of coiled rating.

.2 Instantaneous trips with calibration from 500% to 1,500% of ampere rating of breaker for short circuit protection.

.3 Normal stored energy, closing mechanism to provide quick make operation.

.4 Motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and switch to isolate power supply to spring charging motor.

.5 On-off indicator and spring charging indicator.

.6 Breakers trip setting and fault interrupt rating capacity shall be according to Single Line Drawing and Coordination Study requirements.

.7 Breaker faceplate shall include color-coded visual indicators to indicate Contact stored energy status.

.8 Local control pushbuttons for “open” and “close”.

.3 Accessories:

.1 Microprocessor based trip unit including:

.1 Long time delay.

.2 Short time delay.

.3 Instantaneous time delay.

.4 Ground fault protection.

.5 Flux-transfer shunt trip.

.6 Acceptable Product: Cutler-Hammer Digitrip 520MC.

2.8 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.

.1 Cubicle exteriors gray.

.2 Cubicle interiors white.

2.9 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Nameplates:

.1 White plate, black letters, size seven (7).

.2 Complete switchgear labeled: "600 V".

.3 Main cubicle labeled: "Main Breaker".

.4 Distribution units labeled: "Feeder No. 1", "Feeder No. 2".

3. EXECUTION

3.1 Installation

.1 Locate switchgear assembly as indicated and bolt to floor.

.2 Connect main secondary power supply to main breaker or bus.

.3 Connect load side of breakers in distribution cubicles to distribution feeders.

.4 Check factory made connections for mechanical security and electrical continuity.

.5 Run one (1) grounding conductor 4/0 AWG bare copper from ground bus to ground grid.

.6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

END OF SECTION

INSTRUMENT TRANSFORMERS

1. GENERAL

1.1 References

.1 CAN3-C13, Instrument Transformers.

1.2 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

.2 Indicate dimensions and connection details.

2. PRODUCTS

2.1 Potential Transformers

.1 Potential Transformers: To CAN3-C13, dry type for indoor use, with following characteristics:

.1 Nominal Voltage Class: as indicated.

.2 Rated Frequency: 60 Hz.

.3 Basic Impulse Level: 10 kV.

.4 Voltage Ratio: as required.

.5 Accuracy Rating: 0.3B2.0.

.2 Potential Transformers fused with separate fuse block, Fuses: as required.

2.2 Current Transformers

.1 Current Transformers: To CAN3-C13, dry type for indoor use with following characteristics:

.1 Nominal Voltage Class: as indicated.

.2 Rated Frequency: 60 Hz.

.3 Basic Impulse Level: 10 kV.

.4 Metering Accuracy Ratio: 0.3B2.0.

.5 Relay Accuracy Rating: 2.5H100.

.6 Rated Primary and Secondary Current: as indicated.

.7 Continuous-Current Rating Factor: 150%.

.8 Short-Time Mechanical Current Rating: One and a half (1.5) times primary rating.

.9 Short-Time Thermal Current Rating: One and a half (1.5) times primary rating.

.2 Positive action automatic short-circuiting device in secondary terminals.

2.3 Mounting Brackets

.1 Potential transformers with brackets as required.

.2 Fabricate brackets and channels from electrogalvanized code gauge painted steel.

3. EXECUTION

3.1 Installation

.1 Install instrument transformers and ensure accessibility.

END OF SECTION

MICROPROCESSOR BASED METERING EQUIPMENT

1. GENERAL

1.1 Product Data

.1 Submit product data in accordance with Section 16010 – Electrical General Requirements.

.2 Indicate dimensions and connection details.

2. PRODUCTS

2.1 Microprocessor Based Metering Equipment

.1 Power System Analyzer and Meter.

.1 Where indicated on the drawing, provide a digital line Power Quality Meter and Analyzer device. The Analyzer and meter shall be UL, CSA, and CUL listed and meet ANSI C12.20 (0.5%) energy revenue metering accuracy standard.

.2 The metering equipment shall provide direct reading metered or calculated values of the items listed below and shall auto range between units, kilounits and megaunits for all metered values. The device shall be capable of displaying the frequency distribution in graphic form and shall be capable of displaying the Waveform in graphic form. The device shall be capable of displaying multiple parameters at once, including four (4) user-configurable custom screens, displaying any seven (7) of the parameters listed.

.1 AC current (amperes) in A, B, and C phase, 3-phase average, Neutral (N) and Ground (G) (provide neutral and ground current transformer). Accuracy +/- 0.2%.

.2 AC voltage (volts) for A-B, B-C and C-A, phase average, A-N, B-N and C-N, average phase to N, and N to G. Accuracy +/- 0.2%.

.3 Real Power (Watts), Reactive Power (vars), Apparent Power (VA), Real Energy (WH), Reactive Energy (VARH), Apparent Energy (VAH) for each phase and system. Accuracy +/- 0.4%. Forward/Reverse indication shall be provided.

.4 Frequency (Hertz) Accuracy +/- 0.4%.

.5 Demand values for System Current (Amperes), System Real Power (Watts), System Reactive Power (vars), and System Apparent Power (VA).

.6 Power Factor for both Displacement and Apparent.

.7 Percent Total Harmonic Distortion (THD) for all Currents and Voltages.

.8 K-Factor, Transformer Derating Factor, and Crest Factor.

.3 This device shall provide the following advanced analysis features:

.1 Onboard logging capability, including the ability to log a total of 24 parameters with intervals ranging from 0.13 seconds (every 8 cycles) to twice a week (5,040 minutes). Four separate trends shall be available.

.2 Trend Analysis Screens displaying the minimum and maximum values for each metered value, with all parameters time stamped to 10 millisecond resolution.

.3 Time-of-use metering capability to store energy usage data for time-of-use revenue metering.

.4 Demand Analysis Screens displaying present demand and peak demands for phase currents and power. Peak demands shall display time and date stamped to within 10 millisecond resolution. Demand Window Selection for metered demand values shall be selectable as a fixed or sliding window, a synch, pulse initiation, or a communication system initiation.

.5 Harmonic Analysis Screens shall be capable of being function key triggered to capture a high-speed waveform of two (2) cycles of data sampled at 128 samples per cycle, simultaneously recording all currents and voltages. Data captured shall include the magnitude and the direction of the harmonic source from 1st through the 50th harmonic.

.6 Event/Alarm Analysis Screens shall display data recorded for up to ten (10) event/alarm conditions. For each event/alarm a description of the event/alarm, date, and time of event/alarm shall be recorded (10 mS resolution).

.7 The metering equipment shall be capable of transmitting all data at time of the event via Modbus communications to a personal computer for creating and displaying wave forms.

.8 The meter shall have the ability to store the last 504 meter events in non-volatile memory. Each event will be date and time stamped with 10 millisecond accuracy. The meter shall provide the ability to view the events via the local display or via Modbus communications.

.9 Event/Alarm Condition Levels shall be capable of being triggered by up to 7 of any of 61 conditions when the programmed threshold is exceeded. All shall have programmable time delays from 0.1 to 60 seconds except voltage disturbance, which shall be programmable from 0 to 3,600 cycles.

.4 This metering equipment shall be capable of receiving the following inputs:

.1 Instrument Transformers: Input ranges of this device shall accommodate external current transformers with ranges from 10,000/5 through 5/5 amperes. Provide external current transformers for each phase, neutral and ground circuit with rating as indicated on the drawing or sized for incoming service or associated feeder. The unit shall be capable of overranging up to eight (8) times nominal current rating. Provide fused external potential transformers for up to 500 kV.

.2 Control Power: The device shall also be capable of being supplied from a separate control power source with input range of 100 to 240V AC.

.3 Dry Contacts: Three (3) dry discrete input contacts shall be capable of being monitored, which may be programmed by the user to perform any of the following functions. The status of the input contacts shall be locally displayable and accessible through the communications port.

.1 Trigger an Event/Alarm Analysis including Harmonic Analysis information for display on the device and information for Waveform Analysis and display at a personal computer.

.2 Act as a synchronizing pulse input to synchronize demand windows with a utility provided synchronizing pulse.

.3 Actuate a relay output.

.4 Reset a relay output, peak demand, Minimum/Maximum, or Event Analysis records.

.5 Furnish Relay Output Contacts with four (4) Form C (NO/NC) relay output contacts which shall be capable of being independently programmed for the following functions:

.1 Act as a kWH, kVARH, or kVAH pulse initiator output.

.2 Actuate on one (1) or more Event/Alarm conditions, including discrete inputs and Communication Command signal.

.6 Furnish one (1) 4 to 20 mA analog input and four (4) 4 to 20 mA outputs.

.7 The device shall be fully programmable from the faceplate, including alarm relay and power quality (e.g., harmonic distortion) settings. Programming shall be password protected.

.8 Analyzer shall be complete with Ethernet connection to communicate with the DCSA System.

2.2 Medium Voltage Protective relays

.1 Relays for phase time overcurrent, instantaneous overcurrent and ground fault protection, ANSI 50/51, 50/51G, or 50/51N, shall be incorporated into a single device.

.2 The relay shall be a solid-state microprocessor-based multifunctional type that operates from the 5 ampere secondary output of current transformers. The relay shall provide ANSI 50/51N protective functions for each of the three (3) phases, and ANSI 50/51N or 50/51G ground fault protection functions as shown on the plans or as determined by the coordination study. The relay shall be true rms sensing of each phase and ground. Ground element shall be capable of being utilized in residual, zero sequence, ground source connection schemes, or deactivated.

.3 The primary current transformer rating being used for phase and ground protection feeding the device shall be programmable for current transformers with primary current ratings from 5 through 5,000 amperes.

.4 Both the phase and ground protection curves shall be independently field-selectable and programmable with or without load. Curves shall be selectable from the following:

IEEE: Moderately inverse, very inverse, extremely inverse

IEC: A, B, C or D

Thermal: Flat, lt, I^2t, I^4t

Thermal curves shall be similar to those on low voltage trip units for close coordination with downstream devices. Selectable short delay pickup and short delay time settings shall also be provided. The phase instantaneous overcurrent trip shall have field-programmable pickup points from 1.0 to 25 times current transformer primary rating or NONE. In addition, a field-selectable (ON or OFF) discriminator circuit shall be included such that when phase instantaneous overcurrent has been programmed to NONE, the discriminator circuit shall protect against currents exceeding 11 times current transformer primary rating, only when the breaker is being closed and shall be deactivated after approximately eight (8) cycles.

.5 The relay shall be field-configurable to have either of the following function combinations assigned to its two type "a" contacts: 1) one contact assigned ANSI 51 phase and ANSI 51 ground and the other contact assigned ANSI 50 phase and ANSI 50 ground; 2) one contact assigned ANSI 51/50 phase and the other contact assigned 51/50 ground.

.6 The relay shall have a built-in alphanumeric display capable of displaying the following information with metering accuracy of +/- one (1) percent of full scale (I_n) from 0.04 x I_n to 1 x I_n and +/- two (2) percent of full scale (I_n) from 1 x I_n to 2 x I_n:

.1 Individual phase currents.

.2 Ground current.

.3 Cause of trip.

.4 Magnitude and phase of current causing trip.

.5 Phase or ground indication.

.6 Peak current demand for each phase and ground since last reset.

.7 Current transformer primary rating.

.8 Programmed phase and ground set points.

.7 Relay shall have the following features:

.1 Integral manual testing capability for both phase and ground protection function. Testing shall be selectable to either operate contact outputs or not operate output contacts.

.2 Continuous self-testing of internal circuitry.

.3 Unit failure alarm contact for customer use.

.4 Programmable lockout/self reset after trip function.

.5 Programmable set points for device curve selection.

.6 Programmable inputs, such as current transformer ratios.

.7 Access to program and test modes shall be via sealable hinged cover for security.

.8 Relay shall be suitable for operating temperatures from -30 degrees to 55 degrees C. Relay shall be suitable for operating with humidity from 0 to 95% relative humidity (non-condensing).

.9 Relay shall have Ethernet communication capability. Relay shall be capable of the following over the communication network:

.1 Ability to transmit all information contained in the relay such as currents, set points, cause of trip, magnitude of trip current, and open-close trip status.

.10 Relay alarm and/or trip contacts shall not change state if power is lost or an undervoltage occurs. These contacts shall only cause a trip upon detection of an overcurrent or fault condition based upon programmed settings. A “protection OFF” alarm shall be provided which is normally energized when the relay is powered and the self-diagnostics indicates the unit is functional. Upon loss of power or relay failure, this alarm relay shall be de-energized providing a failsafe protection OFF alarm.

.11 The relay shall be suitable for operating on control power with a nominal input voltage of 12 to 240V AC 60 Hz. When AC control power schemes are shown on the drawings, in addition to control power transformer or remote control power shown or herein specified, dual-source power supply shall be included.

.12 Provide a dual-source power supply (DSPS) for each relay when operated from standard 120V AC, or, 50/60 Hz, auxiliary control power which is normally connected and available. The DSPS shall operate solely from the breaker main current transformers (CTs) during a fault condition, if the normally connected auxiliary AC voltage is not available. A battery or UPS as power shall not be required for reliable tripping under all fault conditions. The DSPS shall operate anytime there is a fault, even after an extended power outage. When the standard auxiliary power supply is not available, the DSPS shall provide enough power to operate the overcurrent relay in the tripped state with currents greater than 1.8 per unit rated secondary current, 9A with a single-phase current, 1.2 per unit secondary current or 6A with

three-phase currents. There shall be no effect on the overcurrent relay trip time accuracy when the DSPS switches from normal AC voltage to fault-current power.

.13 Provide the relay in a drawout case allowing for removal and replacement of the relay unit without disruption of the wiring. The drawout case shall have quick release operation with two-stage disconnect operation. The removal of the relay inner chassis shall disconnect the trip circuits and short the CT secondaries before the unit control power is disconnected. All voltage inputs, discrete inputs and contact outputs shall be disconnected while maintaining security against false tripping. Upon insertion of the relay inner chassis, the control power connections shall be made before the trip circuits are activated to provide additional security against false tripping. Drawout case terminals shall accommodate a bare wire connection, spade or ring terminals. A spare self-shorting contact on the terminal block shall be available to provide alarm indication and/or tripping of circuit breaker upon removal of the relay from the case.

2.3 Acceptable Manufacturers

.1 Eaton Cutler-Hammer – Analyzer – IQ Analyer 6600 or approved equal.

.2 Eaton Cutler-Hammer – Protective Relay – DT 3010 or approved equal.

3. EXECUTION

3.1 Installation

.1 Analyzer and protective relay shall be factory installed and connected in designated cubicles.

END OF SECTION

DISCONNECT SWITCHES FUSED AND NON-FUSED UP TO 600 V - PRIMARY

1. GENERAL

1.1 Description

.1 Provide disconnect switches for 347/600 volt and 120/208 volt distribution as indicated on the Drawings, as manufactured by Eaton Cutler-Hammer or Schneider.

2. PRODUCTS

2.1 Disconnect Switches

.1 Ratings: 600 Volts for 347/600 volt and 277/480 volt distribution, 240 volts for 120/208 volt distribution. Unless otherwise shown, 3 pole for 3 phase, 3 wire distribution, 3 pole and solid neutral for 3 phase 4 wire distribution. Ampere ratings as shown on the drawings or to suit load requirements. For motors, use disconnect switches with HP ratings at least equal to motor HP.

.2 Enclosures: CSA code gauge galvanized steel, hinged doors, external operating handles. Disconnect switches in dry locations shall be EEMAC-1 and EEMAC-3 where exposed to weather. Provide ON-OFF switch position indication on switch enclosure cover.

.3 Finish: One (1) primer coat and one finish coat on all metal surfaces, colours as per Section 16010 - Electrical General Requirements.

.4 Switch mechanisms: Quick make and quick break action with self-wiping contacts, solderless pressure lug connectors. For switches 100 amperes and over, provide non-tracking arc shrouds. All switch poles to operate together from a common operating bar. Provide for padlocking disconnect switches in OFF position. Doors to be interlocked and complete with defeat mechanism, to prevent opening when handle in ON position.

.5 Neutral Bars: Where distribution system has grounded neutral conductor, provide neutral bar where required with ampere rating equal to switch rating, in enclosure. Provide ground bar for terminating ground conductors.

.6 Fuse Holders: Provide fuse holders (relocatable and suitable without adapters) on load side of switches, ampere rating equal to switch ratings, suitable for fuses specified.

2.2 Fuses

.1 All fuses to be 100,000 ampere (minimum) interrupting capacity of the current limited type. In addition, fuses feeding motors to be of the time delay type. Provide one (1) full set of spare fuses, three (3) for each different ampere rating used, stored in suitable enclosure.

3. EXECUTION

3.1 Disconnect Switches

.1 Mounting: Provide supports independent of conduits. Wall mount where possible, otherwise provide Unistrut frame support. Where switches are grouped mount in uniform arrangement.

.2 Wiring: Connect line and load cable to all switches.

.3 Fuse Rating: Install so that rating is visible.

.4 Identification: Provide lamacoid plate in accordance with Section 16010 - Electrical General Requirements, on each switch showing voltage, source of supply and load being fed, for example:

.1 Door Controller.

.2 120/208 Volts.

.3 Fed from PPA.

.5 Name plate to be size 3.

END OF SECTION

GROUNDING - SECONDARY

1. GENERAL

1.1 Description

.1 Supply and install a complete secondary grounding system to include new equipment provided in this Contract. Securely and adequately ground all components of the electrical system in accordance with the requirements of all related sections in the latest Canadian Electrical Code (CEC), Local Building Code and the local Electrical Inspection Branch.

.2 The system is to consist of cables, supports, and all necessary materials and inter-connections to provide a complete system. Measured resistance to ground of the network shall not exceed 5 ohms.

.3 All ground conductors shall be run in conduit.

1.2 References

.1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) 837, Qualifying Permanent Connections Used in Substation Grounding.

.2 Canadian Standards Association (CSA) Z32.1, Safety in Anaesthetizing Locations.

2. PRODUCTS

2.1 Equipment

.1 Cables 2/0 and smaller to be connected to ground bars via Burndy Quiklug Type QA-2B connectors. Connections for cables larger than 3/0 shall be brazed.

.2 All ground wires to be stranded copper TWH complete with a green jacket unless otherwise shown.

.3 Uninsulated ground wires shall be bare stranded copper, soft annealed. Size as indicated.

.4 Main Electrical Room: provide a copper ground bar complete with lugs suitable to terminate all ground cables. Ground bus shall be 12 mm thick, 100 mm high and 1,000 mm long. Bus shall be complete with pre-drilled holes suitable for lug mounting as required. Refer to Drawings for details.

.5 Control Room: provide a copper ground bar complete with lugs suitable to terminate all ground cables. Ground bus shall be 12 mm thick, 100 mm high and 500 mm

long. Bus shall be complete with pre-drilled holes suitable for lug mounting as required. Refer to Drawings for details.

.6 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:

.1 Grounding and bonding bushings.

.2 Protective type clamps.

.3 Bolted type conductor connectors.

.4 Bonding jumpers, straps.

.5 Pressure wire connectors.

3. EXECUTION

3.1 General

.1 Install complete permanent, continuous grounding system, including conductors, accessories. Where EMT is used, run ground wire in conduit. All connectors shall be installed in accordance with Manufactureres' requirements. All frames and metallic enclosures of all electrical equipment and electrically operated equipment shall be grounded through the conduit system or via a ground wire.

.2 All transformers, switchgear, motor control centres, panelboards and splitters fed from the main distribution centre shall be grounded by grounding conductors sized in accordance with the CEC. The ground wire shall be terminated at each end with an appropriate grounding lug which shall be connected to the equipment ground bus. Ground wire to be green TWH. Use mechanical connectors for grounding connections to equipment provided with lugs.

.3 All sub panels such as lighting panels, local distribution panels, etc., shall be grounded with a green ground wire run back to the panel from which it is fed. The ground conductor shall be sized according to the CEC.

.4 All main distribution centres, motor control centres, switchgear, and all panels requiring equipment grounds shall contain a ground bus of adequate size, and tapped for lugs for the ground wire required.

.5 All bolted connections must be accessible.

.6 All motors shall be grounded by means of an adequately sized green ground wire contained within the feeder conduit.

.7 Include a separate green ground wire in all power conduits including branch circuit wiring sized to CEC.

.8 Expansion joints and telescoping sections of raceways shall be bonded using jumper cables as per CEC.

.9 Use Burndy compression connectors or approved equal for all grounding splices and terminations unless otherwise shown on the Drawings. For bolted ground connections use Burndy "Durium" or approved equal hardware.

.10 Connect all transformer neutrals to the main building ground wire, using compression terminations.

.11 Install rigid conduit sleeves where ground wires pass through concrete slabs.

.12 Conduit installed buried in earth or installed in or under grade floor slabs shall have separate ground wire installed, whether the conduits are metal or not.

.13 Ground all utility services to the electrical system ground.

.14 Protect exposed grounding conductors from mechanical injury.

.15 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

.16 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

.17 Soldered joints shall not be permitted.

.18 Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at load end.

.19 Install electrical room ground bus to wall as indicated, utilizing insulated off sets.

3.2 System and Circuit Grounding

.1 Install system and circuit grounding connections to neutral of secondary 600 V system.

3.3 Equipment Grounding

.1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels distribution panels.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Perform ground continuity and resistance tests using method appropriate to Site conditions and to approval of Contract Administrator and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

.4 Disconnect ground fault indicator during tests.

END OF SECTION

DRY TYPE TRANSFORMERS UP TO 600 V PRIMARY

1. GENERAL

.1 Provide enclosed dry type transformers 600 volts primary to 120/208 volts.

.2 Product Data - Three Phase, Four Wire Secondary.

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

.3 Transformers to conform to CSA C57.12 and L2 standards, and are to be approved to Canadian Standards Association (CSA) Code Part 2, Standard C22.2, No. 47 and CSA C9.

2. PRODUCTS

2.1 Transformers

.1 General: Dry type, air-cooled, self-ventilated. Enclosures to be Electrical & Electronic Manufacturer's Association of Canada (EEMAC) 1 type, code gauge steel, complete with ventilation openings, access panels, mounting brackets, and solderless primary and secondary cable connectors. Enclosures to have zinc chromate prime coat and enamel finish coat per Section 16010. Transformers to be single or three phase as noted on the Drawings.

.2 Design

.1 Type: ANN.

.2 3 phase, kVA as indicated on the Drawings, 600 V input, 120/208 V output, 60 Hz.

.3 Voltage primary taps: 2.5% full capacity above and below normal.

.4 Insulation: Class H.

.5 Basic Impulse Level (BIL): 10 kV B.I.L.

.6 Hipot: 4 kV.

.7 Average Sound Level: To meet the local municipal & building codes and meet at minimum the following criteria:

.1 45 dB max. up to 45 kVA.

.2 50 dB max. up to 150 kVA.

.3 55 dB max. up to 300 kVA.

.4 60 dB max. above 500 kVA.

.8 Impedance at 170°C: 6.0% max. up to 112½ kVA.
5.5% max. above 112½ kVA.

.9 Enclosure: EEMAC 1, removable metal front panel.

.10 Mounting: Up to 45 kVA suitable for wall or floor mounting and above 45 kVA suitable for floor mounting unless otherwise shown.

.11 Finish: In accordance with Section 16010 - Electrical General Requirements.

.12 Three Phase Windings: Arrange with three primary windings connected in delta and three secondary windings connected in wye.

.13 Max. Winding Temperature: 150°C rise with temperature continuous full load.

.14 Max. Lead Connection: 55°C rise with temperature continuous full load.

.15 Copper winding.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Label Size: 7.

2.3 Acceptable Manufacturers:

.1 Eaton Culter-Hammer

.2 Schneider

.3 Hammond Manufacturing

.4 Delta Transformers

.5 BEMAG Transformers

3. EXECUTION

3.1 Installation

.1 Mount dry type transformers up to 45 kVA as indicated.

.2 Mount dry type transformers above 45 kVA on floor.

.3 Ensure adequate clearance around transformer for ventilation

.4 Install transformers in level upright position.

.5 Remove shipping supports only after transformer is installed and just before putting into service.

.6 Loosen isolation pad bolts until no compression is visible.

.7 Make primary and secondary connections in accordance with wiring diagram.

.8 Mount transformers as indicated on Drawings and connect primary, secondary, neutral and ground conductors. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

.9 Do not use permanent distribution system dry type transformers for temporary power distribution without permission from the Contract Administrator.

.10 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers on vibration and sound absorbing pads.

.11 Record secondary voltage when transformers are carrying approximately 75% of full load. Adjust tap connections to give a continuous secondary voltage of 120 volts phase to neutral. Set tap connections for above 120 volts rather than below.

.12 Connections to transformers shall be in flexible conduit and shall enter the enclosure below the coils.

.13 Before energization, keep transformers or storage room enclosures above 10°C ambient.

END OF SECTION

PANELBOARDS - BREAKER TYPE

1. GENERAL

1.1 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.

2. PRODUCTS

2.1 Panelboards

.1 Panelboards: Product of one (1) Manufacturer.

.1 Install circuit breakers in panelboards before shipment.

.2 In addition to Canadian Standards Association (CSA) requirements Manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 Panelboards: bus and breakers rated for 250V to be 14 KA, 600V to be 18 KA (symmetrical interrupting capacity or as indicated.

.3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.

.4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.

.5 Two (2) keys for each panelboard and key panelboards alike.

.6 Copper bus with neutral of same ampere rating as mains.

.7 Mains: suitable for bolt-on breakers.

.8 Trim with concealed front bolts and hinges.

.9 Trim and door finish: baked grey enamel.

.10 TVSS surge protection – bus connected

2.2 Breakers

.1 Breakers: Refer to Section 16477 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.

2.3 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution panelboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing location and load of each circuit.

2.4 Acceptable Products

.1 Eaton Cutler-Hammer

.2 Schneider Electric

3. EXECUTION

3.1 Installation

.1 Locate panelboards as indicated and mount securely, plumb, true and square, to adjoining surfaces.

.2 Mount panelboards to height specified in Section 16010 - Electrical General Requirements or as indicated.

.3 Connect loads to circuits.

.4 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

Panel 100

PANEL SCHEDULE										
PANEL ' 100 '										
DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Gate Actuator U-100-SG-1	2HP	15A	1	*			2	15A	2HP	Gate Actuator U-200-SG-1
3#12 - 21mm conduit		3P	3		*		4	3P		3# 12 - 21mm conduit
			5			*	6			
Gate Actuator U-300-SG-1	2HP	15A	7	*			8	60A	2	Welding Receptacle
3#12 -21mm conduit		3P	9		*		10	3P	Rec.	3#6 - 35mm conduit
			11			*	12			
Motor Control Centre MCC UV		60A	13	*			14	40A	15HP	U-416-SF - VFD
3#6 - 35mm conduit		3P	15		*		16	3P		Electrical Room Supply Fan
			17			*	18			3/C #10 Teck Cable
U-424-SF - VFD	5HP	15A	19	*			20	20A	7.5HP	U-411-RF - VFD
UV Process Room		3P	21		*		22	3P		Electrical Room Return Fan
3/C #12 Teck Cable			23			*	24			3/C #12 Teck Cable
U-421-RF - VFD	5HP	15A	25	*			26	50A	20HP	U-417-SF - VFD
UV Process Room		3P	27		*		28	3P		Electrical Room Supply Fan
3/C #12 Teck Cable			29			*	30			3/C #10 Teck Cable
U-426-EF - VFD	1.5HP	15A	31	*			32	30A	10HP	U-412-RF - VFD
UV Process Room		3P	33		*		34	3P		Electrical Room Return Fan
3/C #12 Teck Cable			35			*	36			3/C #10 Teck Cable
U-469-HP	14A	40A	37	*			38	40A	14A	U-470-HP
Cooling Loop Ice Kube		3P	39		*		40	3P		Cooling Loop Ice Kube
3/C # 10 Teck Cable			41			*	42			3/C #10 Teck Cable
U-471-HP	14A	40A	43	*			44	40A	14A	U-472-HP
Cooling Loop Ice Kube		3P	45		*		46	3P		Cooling Loop Ice Kube
3/C #10 Teck Cable			47			*	48			3/C #10 Teck Cable
U-486-HP	14A	40A	49	*			50	40A	14A	U-487-HP
Cooling Loop Ice Kube		3P	51		*		52	3P		Cooling Loop Ice Kube
3/C #10 Teck Cable			53			*	54			3/C #10 Teck Cable
U-475-EB-1	18kW	30A	55	*			56	15A	5A	U-473-HP
Electric Boiler		3P	57		*		58	3P		Cooling Loop Ice Kube
3/C #10 Teck Cable			59			*	60			3/C #12 Teck Cable
U-487-HP	5A	15A	61	*			62			Space
Cooling Loop Ice Kube		3P	63		*		64			Space
3/C #12 Teck Cable			65			*	66			Space
Space			67	*			68			Space
Space			69		*		70			Space
Space			71			*	72			Space
Space			73	*			74			Space
Space			75		*		76			Space
Space			77			*	78			Space
Space			79	*			80	100A	75kVA	Transformer DT-6
Space			81		*		82	3P		75kVA
Space			83			*	84			Cable P040

Voltage: 600V/3Ø/3 wire

Feeder: 3/C 350MCM R90 Teck

Mains: 400A

Main Breaker: N/A

Location: Electrical Room

Power Source: 600V Distribution - Breaker 600-B7

Mounting: Surface

Panel A

PANEL SCHEDULE										
Panel 'A'										
DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
Hydraulic System Centre 1A	50A	70A	1	*			2	70A	50A	Hydraulic System Centre 1B
Hydraulic System Centre 2A	50A	70A	3		*		4	70A	50A	Hydraulic System Centre 2B
Hydraulic System Centre 3A	50A	70A	5			*	6	70A	50A	Hydraulic System Centre 3B
System Control Centre (SCC)	16.7A	30A	7	*			8	30A	1/2HP	U-430-AHU-1 Control Rm AHU
U-440-EF-1 WR Exhaust Fan	100W	15A	9		*		10	30A	1/2HP	U-430-AHU-2 Corridor AHU
U-480-HWT	7.4kW	50A	11			*	12	15A	1HP	U-475-P-1 Boiler Circ. Pump
2/C #6 Teck Cable		2P	13	*			14	3P		3/C #12 Teck Cable
Control Panel CP-1	200W	15A	15		*		16			
Control Panel CP-1	200W	15A	17			*	18	15A		Level Transmitter U005 LIT
Control Panel CP-1	200W	15A	19	*			20	15A		Level Transmitter U060 LIT
Spare		15A	21		*		22	15A		Level Transmitters U170,270, 370
Spare		15A	23			*	24			Space
Spare		15A	25	*			26			Space
Spare		15A	27		*		28			Space
Spare		15A	29			*	30			Space
Motion Detectors		15A	31	*			32	50A	5kW	Panel C
Motorized Damper (Mech)		15A	33		*		34	2P		3/C #4 Teck Cable
Motorized Damper (Mech)		15A	35			*	36			Space
Motorized Damper (Mech)		15A	37	*			38	100A	25kW	Panel B
Motorized Damper (Mech)		15A	39		*		40	3P		4#2 -41mm conduit
Fire Alarm Panel	200W	15A	41			*	42			Plus Ground

Voltage: 120/208V/3Ø/4 wire

Feeder: 3/C 250MCM R90 Teck

Mains: 225A

Main Breaker: N/A

Location: Electrical Room

Power Source: Transfromer DT-6

Mounting: Surface

Panel B

PANEL SCHEDULE										
PANEL 'B'										
DESCRIPTION	LOAD	BKR	CCT	A	B	C	CCT	BKR	LOAD	DESCRIPTION
UV Process Room Lighting	1200W	15A	1	*			2	20A	1400W	Electrical Room Lighting
UV Process Room Lighting	1200W	15A	3		*		4	15A	1000W	Electrical Room Lighting
UV Process Room Lighting	1200W	15A	5			*	6	15A	1000W	Electrical Room Lighting
UV Process Room Lighting	700W	15A	7	*			8	15A	1000W	Electrical Room Lighting
UV Process Room Lighting	900W	15A	9		*		10	15A	1000W	Corridor, Control, WR Ltg.
Exterior Lighting	1000W	15A	11			*	12	15A	2	UV Process Room Recept.
UV Process Room Recept.	3	15A	13	*			14	15A	3	Electrical Room Recept.
UV Process Room Recept.	3	15A	15		*		16	15A	3	Electrical Room Recept.
Control Room Recept	2	15A	17			*	18	15A	1	Washroom Recept.
Control Room Recept	2	15A	19	*			20	15A	2	Lift Station Recept
Mech. Mezz Lighting	800W	15A	21		*		22	15A	4	Mech Mezz Recepts
Air HandlingUnits - Lighting	400W	15A	23			*	24	15A		Spare
Spare		15A	25	*			26	15A		Spare
Spare		15A	27		*		28	15A		Spare
Spare		15A	29			*	30	15A		Spare
Spare		15A	31	*			32			Space
Spare		15A	33		*		34			Space
Spare		15A	35			*	36			Space
Spare		15A	37	*			38			Space
Elec. Rm, Exterior Camera	2	15A	39		*		40			Space
UV Process Rm. Camera	2	15A	41			*	42	15A	3	Exit Lights

Voltage: 120/208/3Ø/4W

Feeder: 4/C #3 R90 in 41 Conduit

Mains: 225A

Main Breaker: N/A

Location: Electrical Room

Power Source: Panel A

Mounting: Surface

Panel C

PANEL SCHEDULE									
Panel 'C' (Sampling Building)									
DESCRIPTION	LOAD	BKR	CCT	A	B	CCT	BKR	LOAD	DESCRIPTION
Lighting	300W	15A	1	*		2	15A	2	General Receptacles Sampling
Electric Baseboard Heater	750W	15A	3		*	4	15A	500W	Refrigerator Recept.
Sampling Pump	800W	15A	5	*		6	15A	87W	Exhaust Fan
Electric Baseboard Heater	750W	15A	7		*	8			Space
Space			9	*		10	40A		Main Breaker
Space			11		*	12	2P		

Voltage: 120/208V/1Ø/3W

Feeder: 3/C #4 Teck Cable Plus Ground

Mains: 100A

Main Breaker: 40A 2P

Location: Sampling Building

Power Source: Panel 'A'

Mounting: Surface

MOULDED CASE CIRCUIT BREAKERS

1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

.2 Include time-current characteristic curves for breakers with interrupting capacity of 22,000A symmetrical (rms) and over at system voltage.

2. PRODUCTS

2.1 Breakers General

.1 Bolt-On Moulded Case Circuit Breaker: Quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.

.2 Common-Trip Breakers: With single handle for multi-pole applications.

.3 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting. Trip settings on breakers with adjustable trips to range from three (3) to eight (8) times current rating.

.4 Circuit breakers with interchangeable trips as indicated.

2.2 Thermal Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 Magnetic Breakers

.1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.

2.4 Moulded Case Switch

.1 Moulded case switch shall be complete with a high instantaneous magnetic fixed trip, factory set to trip at high fault currents.

2.5 Optional Features

.1 Include where indicated on Drawings:

.1 Shunt trip.

.2 Auxiliary switch.

.3 Motor-operated mechanism c/w time delay unit.

.4 Under-voltage release.

.5 On-off locking device.

.6 Handle mechanism.

.7 Keyed interlocks.

.8 Non-auto.

2.6 Enclosure for Individually Mounted Breakers or Moulded Case Switch

.1 Enclosure shall be Canadian Standards Association (CSA) code gauge galvanized steel, hinged door, front mounted external operating handle, lockable in "off" position, Electrical and Electronic Manufacturer's Association of Canada EEMAC-1 unless shown otherwise. Use EEMAC-12, for industrial application, enclosure for wet environment or as shown "WP" on Drawings. Increase enclosure size above standard for large cables.

.2 Where distribution system has grounded neutral conductor, provide neutral bar, with ampere rating equal to breaker/switch rating in enclosure.

3. EXECUTION

3.1 Installation

.1 Install circuit breakers as indicated on Drawings and specified herein.

.2 Install circuit breakers in panelboards to satisfy branch circuit requirements under the Scope of Work of this Contract.

.3 Provide 15% spare quantity of circuit breakers in each panelboard.

.4 Identification: Provide lamacoid plate on each breaker showing voltage, source of supply and load being fed - 120/208 V, 3 phase, 4W fed from LDP No.1 to Splitter Trough No. 1.

END OF SECTION

POWER SURGE PROTECTORS

1. GENERAL

1.1 Related Work

.1 General Electrical Requirements: Section 16010

.2 Panelboards - Breaker Type: Section 16471

1.2 System Description

.1 A transient voltage surge suppressor for the protection of downstream electronic equipment connected to the building power supply. The specified unit shall be compatible with non-linear loads and shall provide effective high-energy transient voltage suppression, surge (TVSS) current diversion and high-frequency electrical noise filtering while connected in parallel with a facility's distribution system. The filtering unit shall utilize non-linear voltage dependent metal oxide varistors or selenium cells. The suppression system's components shall not utilize gas tubes, spark gaps, or silicon avalanche diodes. The device shall be referred to as a TVSS filter for the purpose of this document and Drawings.

2. PRODUCT

2.1 Operation and Environment

.1 Voltage: The TVSS devices shall be suitable for the voltage and systems configuration as indicated on the single line diagram(s).

.2 Maximum Continuous Operating Voltage (MCOV): The maximum continuous operating voltage of the suppressor unit shall be greater than 125% for 120/208 V systems and 115% for 277/480 V and 347/600 V systems.

.3 Protection Modes: Transient voltage surge suppression paths shall be provided for all possible common and normal modes (between each line and ground, neutral and ground, line to line and each line and neutral). The primary suppression path shall not be to ground.

2.2 Suppression Component

.1	Peak surge Current per Phase	120,000 Amps	(Branch Panel Applications)
.2	Let Through Voltage (L-N)	208 V Units	500 V

		600 V Units	1200 V
.3	TVSS clamping components response time	< 1 nanosecond	

2.3 Filtering

.1 TVSS shall contain a high frequency extended range-tracking filter.

.2 Noise attenuation ≥45 dB @ 100 kHz.

2.4 Panelboard Component (Integrated TVSS Panel)

.1 Main Bus: The device shall have a copper, tin-plated main bus.

.2 Circuit Breakers: Are to be of the over center toggle mechanism type which use bolt-on connectors to line side panelboard connectors.

.3 Panelboard Enclosure: The panelboard shall be provided in an Electrical and Electronic Manufacturer's Association of Canada EEMAC-1 enclosure. The TVSS/filter status indicators shall be visible without the need to open the panelboard door. A lockable door shall be provided to limit access to authorized personnel only. Trim assembly shall be tamper proof. The trim (doors) shall be finished in grey ASA61 paint.

.4 Neutral Bus: The unit shall be equipped with a copper 200% rated neutral bus suitable for use with non-linear loads, which shall include a sufficient quantity at solderless type lugs to service the total unit circuit capacity.

.5 Wiring Gutters: The integrated TVSS filtering panel shall be equipped with a complete perimeter wiring gutter with a cross-sectional dimensions of not less that 12,200 mm^2.

.6 Safety and Insulated/Isolated Ground Bus: The integrated filter panel shall have a safety and insulated/isolated ground bus equipped with solderless type lugs of quantity to sufficiently service the circuit loads.

2.5 General Features

.1 The integrated TVSS panel shall be factory installed and connected to the bus bar.

.2 Connectors: Terminals shall be provided for all the necessary input and output power and ground connections on the TVSS.

.3 Enclosure: The specified system shall be provided in a heavy duty National Electrical Manufacturers Association (NEMA) 12 dust tight enclosure with no ventilation openings for maintenance and branch panel applications. Indication of surge current module status shall be visible without opening the door.

.4 Internal Connections: All surge current diversion connections shall be by way of low impedance wiring. Surge current diversion components shall be wired for reliable low impedance connections. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in surge suppression paths.

.5 Unit Status Indicators: Red status indicators shall be provided on the hinged front cover to indicate unit phase status. The absence of the red light shall reliably indicate that one or more surge current diversion phases have failed and that service is needed to restore full operation.

.6 Fuses: The unit shall utilize internal fuses rated with a minimum interrupting capability of 200,000 A or greater.

.7 Identification: The unit shall include Manufacturer's nameplate, Underwriters Laboratories Inc. (UL) rating, and a Canadian Standards Association (CSA) approval on the exterior enclosure.

.8 Warranty: The Manufacturer shall provide a five (5) year warranty on the TVSS filter, a one (1) year warranty on the panelboard and circuit breakers, and a one (1)-year warranty on individual equipment plug-in units. These warranties shall commence from date of shipment.

.9 Testing: Testing at each unit shall include assurance checks, "Hi-Pot" test at two (2) times rated voltage plus 1000 volts per UL requirements, and operation and calibration tests.

2.6 Approved Manufacturers

.1 IT Innovative Technology Inc.

.1	Main panel application	PTE 300
.2	Branch panel application	PTE 300

.2 Cutler Hammer

.1	Main panel applications	Model Visor Series
.2	Branch panel application	Model Visor Series

.3 Tyco International Corporation.

.1 Main and branch panel applications Model PTY-HE

3. EXECUTION

3.1 Installation

.1 Install with Manufacturer's recommended conductors tapped from the electrical service switchboard conductor system. Conductors are to be as short and as straight as possible. Input conductors to the TVSS shall be twisted together to reduce impedance during high frequency filtering.

.2 An appropriately sized manual safety disconnect shall be installed before and in line with the TVSS from the electrical service for the purpose of electrically isolating the device from the system should service be required without interrupting the main service. Coordinate required disconnect ampacity with TVSS Manufacturer.

.3 The TVSS should be following the Manufacturer's recommended practices as outlined in the Manufacturer's installation and Maintenance Manual and in compliance with all applicable electrical codes.

.4 Individual equipment protection devices shall be installed at the same voltage rating as the intended protected equipment and as close as possible to the intended protected equipment.

END OF SECTION

CONTACTORS

1. GENERAL

1.1 Description

.1 Supply and Install contactors as indicated on Drawings and specified herein to ensure a complete operational system.

.2 This Specification covers contactors for voltages up to 600 V. Refer to Drawings for voltage, amperage, number of poles, and auxiliary contacts.

1.2 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

2. PRODUCTS

2.1 Contactors

.1 Contactors: to EEMAC No.1CS.

.2 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. This rating shall be on the basis of incandescent or non-inductive loading for continuous operation. Half size contactors not accepted. All contactors shall have 120V operating coils.

.3 Breaker combination contactor as indicated.

.4 Complete with two (2) normally open and two (2) normally closed auxiliary contacts unless indicated otherwise.

.5 Mount in CSA Enclosure 1 unless otherwise indicated.

.6 Include the following options in cover:

.1 Red indicating lamp.

.2 Hand-Off-Auto selector switch.

.3 On-Off selector switch.

.7 Control transformer: To Section 16825 - Control Devices**,** in contactor enclosure.

2.2 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Provide a size 4 nameplate indicating name of load controlled.

3. EXECUTION

3.1 Installation

.1 Install contactors and connect auxiliary control devices where indicated on Drawings and specified herein.

.2 Contactors shall be mounted separately in suitable CEMA-1 enclosures.

END OF SECTION

GENERAL PROVISIONS FOR INTERIOR LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply and Install lighting fixtures complete with lamps, ballasts and all necessary fittings.

1.2 Code Requirements

.1 Installation of lighting equipment to conform to Section 30, Canadian Electric Code, Part 1, and as amended or supplemented by provincial, municipal or other regulatory agencies having jurisdiction.

1.3 Shop Drawings

.1 Submit a complete list of the types of lighting fixtures, lamps, ballasts and accessories with catalogue illustrations, data sheets, etc. for review. Bind in a suitable booklet and keep one copy of this booklet at the job Site at all times.

.2 Submit complete photometric data, based on actual fixtures proposed for project. Substantiate brightness and efficiency requirements. Photometric data must be produced by a recognized independent laboratory.

1.4 Manufacturer's Operational Test

.1 Test fixtures for acceptance of lamp made to maximum tolerance as required in ANS standards.

.2 Test fixtures with rated lamps for starting and operation.

.3 Check wiring for agreement with design circuit.

.4 Test for short circuits and improper grounds.

.5 Test operation of fixture and lamp with ballast.

1.5 Samples

.1 Provide samples of all fixtures, lamps, ballasts and accessories when requested.

.2 If directed, set up these fixtures on or near Site, to show co-ordination of fit with ceiling and other equipment i.e., mechanical air diffuser assemblies, wiring channels, brackets, davits and standards. Retain fixture design, if approved, at the Site as a control standard. If submitted fixtures are disapproved, resubmit after revision for further field tests until approval is given.

.3 Install one (1) or more sample fixtures in a mock-up of specified ceiling. Pay all costs associated with Work of this trade in connection with construction of mock-up, installation and connection of fixtures, lamps, ballasts and accessories.

1.6 Lamps Used for Temporary Lighting

.1 Fluorescent or mercury lamps may be used for temporary light and lamps used for this purpose will be accepted when the project or portions of the Work are turned over to the City. Spot relamp faulty or burned out lamps prior to this acceptance, without additional cost to the City.

.2 Metal halide, sodium, incandescent and quartz lamps are not to be used for temporary lighting, unless all lamps so used are replaced with new lamps immediately prior to completion at no additional cost to the City.

2. PRODUCTS

.1 All lighting units and associated equipment shall be Manitoba Hydro Power Smart approved where applicable.

.2 Provide, wherever possible, commercially available stock lighting fixtures meeting specified requirements and as shown on the Drawings.

.3 Different fixtures may be supplied by different Manufacturers. Similar fixtures shall be supplied by the same Manufacturer.

.4 Provide only lighting fixtures, which are structurally well designed and constructed, and which use new parts and materials of highest commercial grade available. Unless otherwise specifically noted, fixtures shall be of the quality stated in the Manufacturer's catalogues and data sheets.

.5 Refer to Luminaire Schedule on Drawings for details of fixtures and accessories.

.6 Use self-aligning ball joint hangers for rod suspended fixtures.

.7 Use cadmium plated chains for suspended fixtures in unfinished areas.

3. EXECUTION

3.1 Installation

.1 Install fixtures in accordance with the Manufacturer's requirements, code requirements, and as shown on the Drawings.

.2 Confirm compatibility and interface of other materials with luminaire and ceiling systems. Examine the room finish schedule and reflected ceiling Drawings. Report discrepancies and defer ordering until clarified.

.3 Supply plaster frames, trim rings and backboxes to other trades as the Work requires.

.4 Ground lighting equipment to metal raceway, armour of armoured cable, grounding conductor in non-metallic sheathed cable, or to a separate grounding conductor.

.5 Co-ordinate with other trades to avoid conflicts between luminaires, supports and fittings and mechanical and structural equipment.

.6 Provide guards where fixtures are subject to mechanical damage as required by code or shown on the Drawings.

3.2 Workmanship

.1 Completely clean all glassware, lamps, and hangers. Polish metal parts before completion.

.2 Provide suitable extension couplings for row mounted fixtures.

.3 Protect fixtures, hangers, supports, fastenings and accessory fittings at the Site prior to and during installation. Unless fixtures are erected immediately, after delivery to Site, deliver in original cartons or enclosed in air-tight plastic wrapping. Store in a dry and secure space on Site. Protect hangers, supports, fastenings and accessory fittings against corrosion. Take care during installation to ensure that insulation and corrosion protection is not damaged.

.4 Fixtures which show evidence of corrosion, rough handling, scratching of finishes, etc. are to be replaced with new fixtures at no additional cost.

.5 Install recessed fixtures to permit removal from below, for access to outlet or prewired fixture box.

.6 Hang and mount fixtures to prevent distorting fixture frame, housing, sides or lens frame, and permit correct alignment of several fixtures in a row.

.7 Support fixtures as shown on Drawings, level, plumb and true with structure and other equipment in horizontal or vertical position as intended. Install wall or side bracket mounted fixture housings rigidly and adjust to a neat flush fit with mounting surface.

.8 Adjust length of hangers of suspended fixtures to hang fixture bodies level and in same horizontal plane, unless shown otherwise on Drawings.

.9 Install ceiling canopies to cover suspension attachments and fit tightly to ceiling without restricting alignment of hanger.

.10 For recessed fluorescent fixtures mounted in suspended ceiling with exposed tee bar grid system, support by the ceiling tee bar grid structure. Provide any additional support necessary for oversize fixtures, or to meet code requirements.

.11 Metal inserts, expansion bolts or toggle bolts which do not carry wiring shall be accurately located in relation to outlet boxes, for perfect alignment and spacing of suspension stems or other hangers.

.12 For remote mounted ballasts, supply mounting board and space ballasts in accordance with Manufacturer's directions. Size wiring from ballasts to remote fixtures to meet Manufacturer's requirements.

.13 Remove any noisy ballasts from the fixtures and replace at no additional cost to the City prior to completion.

END OF SECTION

EXIT LIGHTS

1. GENERAL

1.1 Product Data

.1 Submit duct data in accordance with Section 16010 - Electrical General Requirements.

1.2 References

.1 CSA C860.

2. PRODUCTS

2.1 Standard Units

.1 Housing: Molded high impact thermo plastic.

.2 Face and back plates: Molded high impact thermo plastic.

.3 Lamps: LED-2W 120 V.

.4 Letters: 150 mm high x 19 mm, with 13 mm thick stroke, red on white glass, reading EXIT.

.5 Face plate to remain captive for relamping.

.6 Universal mounting.

3. EXECUTION

3.1 Installation

.1 Install exit lights.

.2 Connect fixtures to exit light circuits.

.3 Connect emergency lamp sockets to emergency circuits.

.4 Ensure that exit light circuit breaker is locked in on position.

END OF SECTION

UNIT EQUIPMENT FOR EMERGENCY LIGHTING

1. GENERAL

1.1 Work Included

.1 Supply emergency lighting units complete with all accessories.

1.2 Special Codes

.1 Canadian Electric Code, Part 1, Section 46 “Emergency Systems, Unit Equipment and Exit Signs”.

.2 CSA Standard C22.2 No. 141 “Unit Equipment for Emergency Lighting”.

.3 Manitoba Building Code.

1.3 Product Data

.1 Submit Product data in accordance with Section 16010 - Electrical General Requirements.

.2 Data to indicate system components, mounting method, source of power and special attachments.

1.4 Warranty

.1 For batteries, the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 120 months, with a no-charge replacement during the first five (5) years and a pro-rate charge on the second five (5) years.

2. PRODUCTS

2.1 General

.1 Supply and Install battery power emergency lighting where shown on the Drawings. Lights are to switch “ON” automatically in the event of failure of normal power, and “OFF” on restoration of power. The batteries shall be automatically recharged from a 120 VAC supply.

2.2 Equipment

.1 Supply voltage: 120 V, AC.

.2 Output voltage: 12 V DC.

.3 Operating time: 30 min.

.4 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01 V for plus or minus 10% input variations.

.5 Solid state transfer circuit.

.6 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.

.7 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.

.8 Lamp heads: integral on unit and remote, 345° horizontal and 180° vertical adjustment. Lamp type: tungsten, 12 W, minimum.

.9 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

.10 Finish: Whist Metal.

.11 Auxiliary equipment:

.1 Ammeter

.2 Voltmeter

.3 Test switch

.4 Time delay relay

.5 Battery disconnect device

.6 ac input and dc output terminal blocks inside cabinet

.7 Shelf

.8 Cord and single twist-lock plug connection for ac

.9 RFI suppressors.

2.3 Line Connection

.1 Each battery unit shall be equipped with AC line cord and plug.

2.4 Units

.1 Units to contain solid state battery charger, transfer switch and batteries. Provide all relays, hardware and circuitry for operation specified. Units to have push-to-test switch, “ON” and “CHARGING” lights with extended lamp life.

2.5 Batteries

.1 Unless specifically indicated provide batteries of sufficient watt-hour capacity to power the loads connected to each individual unit for 30 minutes, 12 V, long life, maintenance free, sealed lead acid batteries, contained within the units.

2.6 Wire Guard

.1 Where indicated provide substantial wire guards with chrome finish, for battery units and/or lamps.

2.7 Wiring of Remote Heads

.1 Conduit: type Rigid Galvanized Steel, to Section 16111 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Conductors: # 12 R90 (min.) type to Section 16122 - Wires and Cables 0-1000 V, sized in accordance with manufacturer's recommendations.

3. EXECUTION

3.1 Installation

.1 Mount battery units with the bottom of the enclosure not less than 2.2 m above the floor, where practicable.

.2 Install duplex receptacle adjacent to unit and connect to 1Ø, 120V unswitched area lighting circuit.

.3 Where applicable wire from unit to exit lights.

.4 Wiring from units to remote heads and/or exit lights shall be sized to prevent voltage drop of more than 5%.

.5 All emergency heads shall be properly aimed.

END OF SECTION

FIRE ALARM SYSTEMS

1. GENERAL

1.1 Related Work

.1 Conduits, Conduit Fastenings and Conduit Fittings: Section 16111

.2 Wires and Cables 0-1000 V: Section 16122

.3 Instrumentation and Control Division 17

1.2 References

.1 CAN/ULC-S524, Installation of Fire Alarm Systems.

.2 ULC-S525, Audible Signal Appliances for Fire Alarm Systems.

.3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.

.4 CAN/ULC-S527, Control Units, Fire Alarm.

.5 CAN/ULC-S528, Manual Pull Stations.

.6 CAN/ULC-S529, Smoke Detectors, Fire Alarm.

.7 CAN/ULC-S530, Heat Actuated Fire Detectors, Fire Alarm.

.8 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.

.9 CAN/ULC-S537, Verification of Fire Alarm Systems.

.10 NBC, National Building Code of Canada.

.11 CSA C22.1 Section 32, Fire Alarm Systems and Fire Pumps.

.12 Local Building Code.

1.3 Description of System

.1 System includes:

.1 Control panel to carry out fire alarm and protection functions including receiving alarm signals, initiating general alarm, supervising system continuously, actuating zone annunciators, and initiating trouble signals.

.2 Trouble signal devices.

.3 Power supply facilities.

.4 Manual alarm stations.

.5 Automatic alarm initiating devices.

.6 Audible signal devices.

.7 End-of-line devices.

.8 Annunciators.

.9 Visual alarm signal devices.

.10 Ancillary devices.

1.4 Shop Drawings

.1 Submit shop Drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include:

.1 Layout of equipment.

.2 Zoning.

.3 Complete wiring diagram, including schematics of modules.

1.5 Operation and Maintenance Data

.1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Include:

.1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Technical data - illustrated parts lists with parts catalogue numbers.

.3 Copy of approved Shop Drawings.

.4 List of recommended spare parts for system.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Section 01300 – Submittals.

1.7 Maintenance

.1 Provide one (1) year's free maintenance with two (2) inspections by Manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to the City and Contract Administrator.

1.8 Training

.1 Arrange and pay for two (2) on-site lectures and demonstrations by fire alarm equipment Manufacturer to train operational personnel in use and maintenance of fire alarm system. Seminars will use actual demonstration.

.2 A representative from the Manufacturers shall attend the seminar.

2. PRODUCTS

2.1 Materials

.1 Equipment and devices: ULC listed and labeled and supplied by single Manufacturer.

.2 Power supply: to CAN/ULC-S524.

.3 Audible signal devices: to ULC-S525.

.4 Visual signal devices: to CAN/ULC-S526.

.5 Control unit: to CAN/ULC-S527.

.6 Manual pull stations: to CAN/ULC-S528.

.7 Thermal detectors: to CAN/ULC-S530.

.8 Smoke detectors: to CAN/ULC-S529.

2.2 System Operation

.1 Single stage operation. Operation of any alarm initiating device to:

.1 Cause audible signal devices to sound throughout building.

.2 Transmit signal to fire department via monitoring station.

.3 Cause zone of alarm device to be indicated on control panel.

.4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.

.5 Cause fire doors and smoke control doors if normally held open, to close automatically.

2.3 Control Panel

.1 Class B.

.2 Single stage operation.

.3 Zoned.

.4 Non-coded.

.5 Enclosure: CSA Enclosure 1, c/w lockable concealed hinged door, full viewing window, flush lock and two (2) keys. Enclosure to be suitable for surface wall mounting.

.6 Supervised, modular design with plug-in modules:

.1 Alarm receiver with trouble and alarm indications, for class B initiating circuit.

.2 Spare zones: compatible with smoke detectors and open circuit devices.

.3 Space for future modules.

.4 Latching type supervisory receiver circuits. Discrete indication for both off-normal and trouble.

.7 Components:

.1 Coded alarm receiver panel with trouble and alarm indications for class B initiating circuit.

.2 Single stage alarm pulse rate panels:

.1 Single stroke control type for output to signal control panel continuously.

.3 Audible signal control panel with two (2) control circuits complete with terminals for wiring and two (2) plug-in modules for dc signals up to 2.0 A load with trouble indication with class B connections.

.4 Common control and power units:

.1 Control panel containing following indications and controls:

.1 "Power on" LED (green) to monitor primary source of power to system.

.2 "Power trouble" indication.

.3 "Ground trouble" indication.

.4 "Remote annunciator trouble" indication.

.5 "System trouble" indication.

.6 "System trouble" buzzer and silence switch c/w trouble resound feature.

.7 System reset switch.

.8 "LED test" switch if applicable.

.9 "Alarm silence" switch to silence signals manually. If new alarm occurs after signals have been silenced, signals to resound.

.10 "Signals silenced" indication.

.2 Master power supply panel to provide 24 V dc to system from 120 V AC, 60 Hz input.

.5 Auxiliary relays: plug-in type, dust cover, supervised against unauthorized removal by common trouble circuit.

.1 Contact terminal size: capable of accepting 22-12 AWG wire.

.6 Fire Alarm shall be able to communicate with the DCS System via Ethernet connection port.

2.4 Power Supply

.1 120 V, ac, 60 Hz input, 24 V dc output from rectifier to operate alarm and signal circuits. Power supply from 120 /208 V local power panel. Include surge protection on incoming power wiring.

.2 Standby nickel cadmium battery unit with automatic battery charger to provide supervisory and trouble signal current for 24 hours, plus general alarm load for minimum of five (5) minutes, complete with voltmeter and charging meter. Unit to be sized to carry the complete fire alarm system.

2.5 Manual Alarm Stations

.1 Manual alarm stations: pull lever, wall mounted surface type, non-coded single pole normally open contact for single stage bilingual signage.

2.6 Automatic Alarm Initiating Devices

.1 Heat detectors, fixed temperature, non-restorable, rated 88°C.

.2 Smoke detector: ionization type air duct type with sampling tubes with protective housing.

.1 Twistlock Plug-in type with fixed base.

.2 Wire-in base assembly with integral red alarm LED, and terminals for remote alarm LED.

2.7 Audible Signal Devices

.1 Bells: surface mounted, single stroke, polarized, 24 V DC, 250 mm.

.2 Bells: vibrating type, gongs of special alloy steel, 24 V DC, 250 mm.

2.8 End-of-Line Devices

.1 End-of-line devices to control supervisory current in alarm circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.9 Ancillary Devices

.1 Remote relay unit to initiate fan shutdown.

3. EXECUTION

3.1 Installation

.1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-4.

.2 Install main control panel and connect to ac power supply.

.3 Locate and Install manual alarm stations and connect to alarm circuit wiring.

.4 Locate and Install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to main control panel.

.6 Locate and Install audible signal devices and connect to signaling circuits.

.7 Connect signaling circuits to main control panel.

.8 Install end-of-line devices at end of alarm and signaling circuits, in a separate box not more than 1,730 mm above finished floor.

.9 Locate and Install remote relay units to control fan shut down.

.10 Mount battery pack and charger in the control cabinet.

.11 Connect remote fire alarm output to Control Panel UV CP1 for alarm transmission to the Administration Building Server Room. Exact location shall be determined on Site.

3.2 Wiring

.1 Ensure conductors are routed in such a manner to provide required fire rating.

.2 Signal circuits to be wired with a minimum 2-# 14 R90 per zone. In no case shall the voltage drop to any signal exceed 10%.

.3 Alarm initiating devices to be wired with multi conductor # 18 R90 cables as required in accordance with the Canadian Electrical Code. Circuit resistance shall not exceed 50 ohms.

.4 All wiring will be terminated into the terminal strips in the fire alarm cabinet with all wiring fully labeled. All cabling to be neat with cables bundled and wrapped inside the cabinets. No splicing will be allowed within the cabinets. A complete schedule of all wiring terminations will be mounted inside each control unit. A complete schematic with all devices, cable labeling information, destinations, etc. will be included with the Shop Drawings.

3.3 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and System and CAN/ULC-S537.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors transmit alarm to control panel and actuate general alarm ancillary devices.

.2 Simulate grounds and breaks on alarm and signaling circuits to ensure proper operation of system.

.3 Class B circuits.

.1 Test each conductor on all circuits for capability of providing alarm signal on line side of single open-circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

3.4 Verification and Certification

.1 The Manufacturer shall make an inspection of the fire alarm equipment, including those components necessary to the direct operation of the system such as detectors and controls,

whether or not manufactured by the Manufacturer added under this Contract. The inspector shall comprise an examination of such equipment for the following.

.1 That the type of equipment installed is that designated by the Specification.

.2 That the wiring connections to all equipment components show that the installer undertook to have observed ULC and CSA requirements.

.3 That equipment of the Manufacturer's manufacture has been installed in accordance with the Manufacturer's recommendations and that all signaling devices of whatever manufacture have been operated or tested to verify their operation.

.4 That the supervisory wiring of those items of equipment connected to a supervised circuit is operating and that the governmental regulations, if any, concerning such supervisory wiring have been met to the satisfaction of inspecting officials.

.5 To assist the Contractor in preparing his bid the Manufacturer shall indicate the number of hours necessary to complete this inspection prior to closing of tenders, and the number of hours necessary to provide a seminar on the system for the building City.

.2 The system shall be tested and verified according to requirements of CAN/ULC-S537 Standard for Verification of Fire Alarm System Installations. The complete verification procedure will be under the control and supervision of the Contract Administrator. The services of the Contractor and representatives of the fire alarm Manufacturer are required for the verification. The following is a rough breakdown of the responsibilities of each part participating in the verification. The following is a rough breakdown of the responsibilities of each party participating in the verification. This list does not necessarily note all the required Work. The Contractor and fire alarm Manufacturer shall provide equipment and manpower as necessary to complete the verification to the Contract Administrator's requirements and approval.

.3 Contractor:

.1 Remove/reinstall devices.

.2 Activate alarms.

.3 Activate trouble alarms.

.4 Provide 1 pair of radios.

.5 All Work to be 100% complete.

.6 Provide necessary manpower.

.7 Correct deficiencies.

.8 Coordinate and schedule verification (all two weeks notice).

.4 Manufacturer:

.1 Ensure correct operation of all alarms, signals, auxiliary functions, trouble indication.

.2 Record all data and issue report and certificate of verification.

.3 Correct any deficiencies.

.4 Check, calibrate, adjust and confirm correct operation of control panels, annunciator.

.5 Generally assure that all aspects of system function properly.

.6 Provide all test equipment, including sound pressure level meter, volt meter, aerosol test smoke.

.5 Contract Administrator:

.1 Direct and supervise verification.

.2 Check and ensure that system is applied and installed to all applicable codes.

.3 Review test documentation, give to the City and fire authorities.

.6 All costs involved in this inspection, including Manufacturers, electrical Contractors included in total price.

.7 Inspection Certification: On completion of the inspection and when all of the above conditions have been complied with, the Manufacturer shall issue to the Contract Administrator:

.1 A copy of the inspecting technician's report showing location of each device and certifying the test results of each device.

.2 A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification have been rendered.

.3 Seal the certificate with the seal of a Professional Engineer registered in the Province of Manitoba.

.4 Proof of liability insurance for the inspection.

.8 Include for complete verification and test of all devices, etc. at six (6) months after completion of initial verification.

END OF SECTION

SECURITY DOOR SUPERVISION

1. GENERAL

1.1 Related Work

.1	General Electrical Requirements:	Section 16010
.2	Conduits, Conduit Fastening and Conduit Fittings:	Section 16111
.3	Wire and Cables – 0-1000V	Section 16122
.4	Outlet Boxes, Conduit Boxes and Fittings:	Section 16132
.5	Instrumentation and Control	Division 17

1.2 Requirements

.1 Installation subject to approval, inspection and test prior to final acceptance.

.2 All equipment to be CSA or ULC approved.

.3 Installation shall conform to the requirements of the Canadian Electrical Code.

1.3 Scope of Work

.1 Provide Motion detector and door contacts at locations indicated on the Drawings and specified herein.

.2 Provide complete conduit system for motion detection door access controllers and door contacts as indicated on Drawings.

.3 Supply and install a complete security CCTV system as indicated on the Drawings and specified herein. System shall be complete with cameras, lenses, housing, mounting hardware, cable and miscellaneous equipment to form a complete operating system. System to be connected to existing switcher and monitoring system located in the Main Administration Building Server Room. Exact termination location to be determined on-site.

1.4 Shop Drawings

.1 Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.

2. PRODUCTS

2.1 Motion Detectors

.1 Motion detectors for use in rooms indicated to detect unauthorized movement with in the range of the detector.

2.2 Door Switches

.1 Door switches: suitable for surface mounting on inside of door as indicated.

2.3 Security CCTV System

.1 Cameras to be Pelco CCC2400S-4 colour CCD camera complete with 8 mm wide-angle lens and indoor housing, Pelco EH100-8 wall mounted enclosure.

.2 Camera to be Pelco CCC2400S-4 colour CCD camera complete with 8 mm wide-angle lens and out door heated housing, Pelco EH3508 wall mounted enclosure.

.3 Camera housing to be suitable for damp location within the building and weatherproof with internal heater for exterior camera.

3. EXECUTION

3.1 Installation

.1 Install a complete wire and conduit system for security equipment as indicated. Minimum conduit size to be 20 mm.

.2 Minimum wire size No. 18 AWG for all hardware. Data link cables to be in accordance with manufactures recommendations. Terminate system wiring in Control Panel UV CP1. Refer to Division 17 for detail of copper to fibre conversion and extension

.3 Conductors termination in panels shall be made on terminal strips with separate point for each conductor. All such stripes to be number identified.

.4 All wiring shall be labeled at each end, termination point or junction.

.5 Install all security equipment indicated.

.6 Test complete system to ensure compliance with the Specification and manufactures recommendations.

.7 Provide power from local 120 V circuits to each camera. All security cameras shall be powered from the same phase.

.8 Security Equipment and CCTV camera units to be connected to new Control Panel UV CP1 for conversion from copper wire to fibre optic. The fibre optics will be installed from UV CP1 control panel to existing main related monitoring equipment located in the Administration Building Server Room. Final connections at this point shall be determined on-site.

END OF SECTION

MOTOR STARTERS TO 600 V

1. GENERAL

1.1 References

.1 National Electronic Manufacturers Association (NEMA) Contactors and Motor-starters.

1.2 Related Work

.1	Variable Frequency Drive	Section 16815
.2	Thermistors:	Section 16930
.3	Connections to Mechanical Equipment:	Section 16950

1.3 Starter Requirements

.1 In general, there are categories of starting equipment for three phase motors.

.1 Integral Mounted Starters: Some items of mechanical equipment such as boilers, have the starter mounted as part of the equipment. For this equipment, supply disconnects and wire to the terminals of the equipment.

.2 Separately Mounted Starters: For motors without integral mounted starters, supply separately mounted starters as indicated on the Drawings and wire the equipment.

.3 Starters in (Motor Control Centres MCCs): For motors fed from motor control centre, wire from the equipment to the MCC.

.2 Provide manual starters for all single phase motors unless otherwise indicated on the motor schedule.

.3 Provide interlocking between starters where required.

.4 All starter accessories such as pilot lights, Hand-Off-Auto, Start-Stop, etc. whether integrally or remote mounted shall be heavy-duty oil tight, unless otherwise specified.

1.4 Shop Drawings and Product Data

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements and Division 1.

.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 data for motor starters for incorporation into manual specified in Section 16010 - Electrical General requirements.

.2 Include operation and maintenance data for each type and style of starter.

1.6 Maintenance Materials

.1 Provide maintenance materials in accordance with Division 01 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.

.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 Manufacturer's Association of Canada (EEMAC) 4.

2.3 For all motors 22.4 kW and above, the starters shall contain thermistor control relay and accessories.

2.4 Manual Motor Starters

.1 Manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:

.1 Switching mechanism, quick make and break.

.2 Overload heaters, manual reset, trip indicating handle.

.3 Rated volts and poles to suit application.

.2 Accessories:

.1 Toggle switch or push-button: heavy duty oil-tight labelled as indicated.

.2 Indicating lights: heavy duty oil tight type and colour as indicated.

.3 Locking tab to permit padlocking in "ON" or "OFF" position.

2.5 Full Voltage Non Reversing (FVNR) Magnetic Starters

.1 Magnetic and combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:

.1 Contactor solenoid operated rapid action type.

.2 Motor overload protective device in each phase, manually reset from outside enclosure.

.3 Wiring and schematic diagram inside starter enclosure in visible location.

.4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.

.2 Combination type starters to include motor circuit interrupter with operating lever on outside of enclosure to control motor circuit interrupter, and provision for:

.1 Locking in "OFF" position with up to 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 or Selector switches: heavy-duty oil tight labelled as indicated.

.2 Indicating lights: heavy duty oil tight type and red pilot light to indicate energized motor circuit and where called for, green pilot light to indicate de-energized motor circuit. Pilot lights to be push-to-test transformer type.

.3 In addition to standard, 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.

2.6 Control Transformer

.1 A control transformer of sufficient VA capacity, dry type, with primary voltage as indicated and 120V secondary, complete with primary and secondary fuses (HRC Form J), installed in with starter as indicated.

.2 Size control transformer for control circuit load plus 20% spare capacity.

2.7 Finishes

.1 Apply finishes to enclosure in accordance with Section 16010 Electrical General Requirements.

2.8 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.2 Manual starter designation label, white plate, black letters, size 1, engraved as indicated.

.3 Magnetic starter designation label, white plate, black letters, engraved as indicated.

3. EXECUTION

3.1 Installation

.1 Install starters, connect power and control as indicated.

.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 startup to ensure motor operation is satisfactory and relays provide proper protection. For side inlet fans and other long acceleration time loads, provide special overload relays to suite the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems and manufacturer's instructions.

.2 Operate switches, contactors to verify correct functioning.

.3 Perform starting and stopping sequences of contactors and relays.

.4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

END OF SECTION

Motor Schedule

MOTOR SCHEDULE

MOTOR				STARTER										POWER						
EQUIP. NO.	DESCRIPTION	EQUIP. LOAD	V/PH	MCC	SIZE	TYPE	MAN.	MAG.	S/S	PL	H.O.A.	OVERCURRENT DEVICE	LOCATION	PANEL	CCT.	FEEDER	CAP. SIZE	DISC. TYPE	INTERLOCK	REMARKS
U-410-AHU-1	U-416-SF Elec. Rm.	15HP	600/3									40A-3P	Mezzanine	100	14,16,18	3/C#10		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
	U-411-RF Elec. Rm.	7.5HP	600/3									20A-3P	Mezzanine	100	20,22,24	3/C#12		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
	U-417-SF Elec. Rm.	20HP	600/3									50A-3P	Mezzanine	100	26,28,30	3/C#10		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
	U-412-RF Elec. Rm.	10HP	600/3									30A-3P	Mezzanine	100	32,34,36	3/C#10		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
U-420-AHU-1	U-424-SF UV Rm.	5HP	600/3									15A-3P	UV Room	100	19,21,23	3/C#12		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
	U-421-RF UV Rm.	5HP	600/3									15A-3P	UV Room	100	25,27,29	3/C#12		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
U-419-EF	Electrical Room Exhaust Fan	15HP	600/3	1A	2			*		*	*	30MCP	Roof	MCC		3/C#10		Div. 16	DCC Cont.	
U-426-EF	UV Room Exhaust Fan	1-1/2HP	600/3									15A-3P	Roof	100	31,33,35	3/C#12		Div. 16	DCC Cont.	VFD by Div. 15 installed byDiv. 16 Note 2
U-432-SF	Control Room Fan Coil Unit	1/2 HP	120/1				*					15A-1P	Corridor	A	8	2#12		Div. 16	DCC Cont.	
U-434-SF	Corridor & Washroom Fan Coil	1/2 HP	120/1				*					15A-1P	Corridor	A	10	2#12		Div. 16	DCC Cont.	
U-440-EF	Wash Room Exhaust Fan	87W	120/1				*					15A-1P	Washroom	A	9	2#12		Div. 15		
U-445-EF	Sampling Building Exhaust Fan	87W	120/1				*					15A-1P	Sampling Bldg	C	6	2#12		Div. 15		
U-451-P	HX Loop Pump	2HP	600/3	1B	1			*		*	*	7MCP	UV Room	MCC		3/C#12 Teck		Div. 16	Temp Sensor	
U-452-P	HX Loop Pump	2HP	600/3	1C	1			*		*	*	7MCP	UV Room	MCC		3/C#12 Teck		Div. 16	Temp Sensor	
U-461-P	Cond Loop Pump	1.5HP	600/3	1D	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-1	
U-462-P	Evap Loop Pump	2HP	600/3	1E	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-1	
U-463-P	Cond Loop Pump	1-1/2HP	600/3	1F	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-2	
U-464-P	Evap Loop Pump	2HP	600/3	2A	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-2	
U-465-P	Cond Loop Pump	2HP	600/3	2B	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-3	
U-466-P	Evap Loop Pump	3HP	600/3	2C	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-3	
U-467-P	Cond Loop Pump	1-1/2HP	600/3	2D	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-4	
U-468-P	Evap Loop Pump	2HP	600/3	2E	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	460-HP-4	
U-481-P	Cond Loop Pump ITT	1-1/2HP	600/3	2F	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	470-HP-1	
U-482-P	Evap Loop Pump ITT	2HP	600/3	3A	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	470-HP-1	
U-483-P	Cond Loop Pump ITT	1-1/2HP	600/3	3B	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	470-HP-2	
U-484-P	Evap Loop Pump ITT	2HP	600/3	3C	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	470-HP-2	
U-490-P-1	Flushing Water	2.5HP	600/3	3D	1			*		*	*	7MCP	UV Room	MCC		3/C#12 Teck		Div. 16	U-490-PT	Interlock with expansion tank pressure sw
U-469-HP	Cooling Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	37,39,41	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-470-HP	Cooling Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	38,40,42	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-471-HP	Cooling Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	43,45,47	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-472-HP	Cooling Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	44,46,48	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-473-HP	Cooling Loop Ice Kube	5A	600/3									20A-3P	Mezzanine	100	55,57,59	3/c#12 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-486-HP	Heating Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	49,51,53	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-487-HP	Heating Loop Ice Kube	14A	600/3									40A-3P	Mezzanine	100	50,52,54	3/C#10 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15

Motor Schedule

MOTOR SCHEDULE																				
MOTOR				STARTER										POWER						
EQUIP. NO.	DESCRIPTION	EQUIP. LOAD	V/PH	MCC	SIZE	TYPE	MAN.	MAG.	S/S	PL	H.O.A.	OVERCURRENT DEVICE	LOCATION	PANEL	CCT.	FEEDER	CAP. SIZE	DISC. TYPE	INTERLOCK	REMARKS
U-488-HP	Heating Loop Ice Kube	5A	600/3									20A-3P	Mezzanine	100	61,63,65	3/c#12 Teck		Div. 15	Temp Sensor	Package Unit. Starter By Div. 15
U-480-HWT-1	Hot Water Heater	7.6kW	208/1									50A-2P	Washroom	A	11,13	2/C#6 Teck		Div. 16		
U-485-DHWP	DHW Recirc Pump	23 w	115/1									15A-1P	Washroom	B		2#12				
U-489-EB	Electric Boiler	18kW	600/3									30A-3P	Mezzanine	100	55,57,59	3/C #10 Teck		Div. 16	Temp Sensor	
U-455-AC-1	Air Compressor	3HP	600/3	3E	1			*		*	*	7MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	Press. Sw.	
U-455-AC-2	Air Compressor	5HP	600/3	3F	1			*		*	*	15MCP	Mezzanine	MCC		3/C#12 Teck		Div. 16	Press. Sw.	
U-010-P-1	Lift Pump No.-1	170HP	600/3									800AF/300AT	Lift Station	Dis. 600	B-7	3/C #4/0 Teck		Div. 16	Level Sensor	Harmonic Filter and VFD Note 1
U-020-P-2	Lift Pump No.-2	170HP	600/3									800AF/300AT	Lift Station	Dis. 600	B-6	3/C #4/0 Teck		Div. 16	Level Sensor	Harmonic Filter and VFD Note 1
U-030-P-3	Lift Pump No.-3	170HP	600/3									800AF/300AT	Lift Station	Dis. 600	B-5	3/C #4/0 Teck		Div. 16	Level Sensor	Harmonic Filter and VFD Note 1
U-040-P-4	Lift Pump No.-4	170HP	600/3									800AF/300AT	Lift Station	Dis. 600	B-4	3/C #4/0 Teck		Div. 16	Level Sensor	Harmonic Filter and VFD Note 1
U-050-P-5	Lift Pump No.-5	170HP	600/3									800AF/300AT	Lift Station	Dis. 600	B-3	3/C #4/0 Teck		Div. 16	Level Sensor	Harmonic Filter and VFD Note 1
U-485-P	Boiler Circulation Pump	1HP	208/3									15A-3P	Mezzanine	A	12,14,16	3/C #12 Teck		Div. 16		
U-100-SG-1	Valve Actuator #1	2HP	600/3									15A-3P	UV Room	100	1, 3, 5	3/C #12 Teck			UV SCC	Starter complete with operator
U-200-SG-1	Valve Actuator #2	2HP	600/3									15A-3P	UV Room	100	2, 4, 6	3/C #12 Teck			UV SCC	Starter complete with operator
U-300-SG-1	Valve Actuator #3	2HP	600/3									15A-3P	UV Room	100	7, 9, 11	3/C #12 Teck			UV SCC	Starter complete with operator
U-002 SG-1	Valve Actuator	5HP	600/3									15A-3P	Grit Building	MCC-1G	Sect. 1	3/C #12 Teck				MCC located in Grit Building Electrical Rm.

Note
1. VFD's and harmonic filters to be supplied by the City to the contractor for installation of pumps P-1 to P-5.
2. VFD's Associated with HVAC equipment to be supplied under Div. 15 and installed under Div.16

VARIABLE FREQUENCY DRIVES

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

.2 Process: Division 11

1.2 Scope

.1 Division 15 Contractor shall supply Variable Frequency Drive (VFD) controllers for heating, ventilation, and air conditioning (HVAC) equipment as herein specified.

.2 Division 16 Contractor shall install, wire and connect HVAC VFD controllers and indicated on the drawings.

.3 Division 16 Contractor shall install, wire and connect VFD units associated with the Bid Opportunity 89-2005 “Supply of Axial Flow Pumps & Variable Frequency Drives”. VFD units will be provided to this Contractor for installation by the City.

1.3 Standards Motor

.1 All VFDs supplied under this Contract meet or exceed the following specifications.

.2 Provide a complete inventory (as specified) 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 Electric Manufacturers Association (NEMA) MG1 Part 31.

.4 Harmonic loading will not exceed a motor service factor of 1.0.

.5 Products shall comply with Institute of Electrical and Electrical Engineers (IEEE) Standard 519.

.6 VFD unit shall be Underwriters Laboratories (UL) listed and Canadian Standards 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.

1.4 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), prior to acceptance of the equipment.

.2 Field testing

1. The VFD supplier shall provide on site startup, fine-tuning, commissioning, operator training and instruction.

2. The VFD supplier shall provide site functionality test reports indicating loading/current levels during testing as well as control point proving results.

3. The VFD supplier shall ensure shaft to ground voltages do not exceed 1.5 volts at any speed or load requirement.

4. Allow for all costs and labour for as many trips as necessary to complete requirements.

5. It is the intent of this specification to provide a VFD installation that does not adversely affect the electrical system. Included in the Contract Documents is information on the electrical system including:

   .1 Single line drawing.

   .2 Additional information on electrical system layout and load profile.

   The VFD supplier can use this information to evaluate the predicted effect of the VFD installation on the electrical system and advise the Contract Administrator of these effects. For the purposes of analysis, the point of common coupling (PCC) will be taken as the secondaries of the main distribution transformers.

6. The Contractor, in conjunction with the Contract Administrator, will conduct a harmonic analysis upon completion of fine-tuning and commissioning phase of the installation. The harmonic analysis will be conducted at 50%, 75%, and 100% speed under normal load conditions and perform a Fourier (FFT) transform analysis spectrum for each waveform covering the fundamental to the 31st harmonic. Should the waveform analysis indicate that either the input or output voltage and current levels of the VFD(s) exceed NEMA Standards for electric motors and IEEE 519, the VFD supplier shall provide, at their cost, all the necessary line filtering equipment to correct the harmonic distortion back to the levels prior to the installation of the VFD(s).

.3 Provide certified copies of all production test results required by CSA and NEMA.

1.5 Warranty

.1 The VFD supplier shall provide a warranty coverage for a period of two (2) years upon the Contractor being granted Final Acceptance and the warranty period has commenced.

.2 VFD supplier will review specifications of motors for application compatibility. The Contractor shall obtain and submit written approval from both the motor and VFD suppliers confirming that both pieces of equipment are compatible when used together to maintain the required warranty.

.3 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. This must be included with all bid submissions.

.4 The VFD supplier shall guarantee that parts for drive units will be available for a minimum of ten (10) years from time of delivery.

2. PRODUCTS

2.1 Variable Frequency Drives

.1 Variable Frequency Drives as supplied by one of the following acceptable manufacturers:

.1 Asea Brown Boveri Ltd. (ABB) - ACS 800 series.

.2 Variable speed controller shall be electronic adjustable frequency and voltage output unit.

.3 The VFD shall employ a minimum 6-pulse pulse width modulated (PWM) 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 minutes and 135% for one 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 Input voltage shall be as indicated on motor schedules and drawings (line voltage variation ±10%) Based on 347/600 volt systems (Not 575V). 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.

.6 Input frequency setting signal will be selective between 4-20 mA or 0-10v DC. Output speed monitoring signal shall be selective between 4-20 mA or 0-10 v DC.

.7 Enclosure:

.1 Drive shall be installed in individual CSA 1 enclosure, drip proof or Nema 12 as indicated on drawings. Filters to be provided for any forced air-cooled enclosures as

required by the supplier. 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 VFDs is 1m.

.8 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 sixty (60) seconds.

.4 Overcurrent instantaneous trip 250%.

.5 Programmable short-circuit protection.

.6 Programmable ground fault protection.

.7 Overvoltage/overcurrent DC bus monitor/protection.

.8 Undervoltage protection.

.9 Loss of phase and phase unbalance protection.

.10 Inverter over-temperature protection.

.11 Capable of running without motor for startup.

.12 Output filter package (as required) to limit motor voltage to 1200 volts maximum at motor terminals. A reflective wave trap mounted at the motor may be used to accomplish this.

.13 Longlead (motor feeder) filter package, as required for these installations. Supplier 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 bid submission, and the Contractor is responsible for carrying all such costs in their bid price.

.14 Maximum acceptable noise level is 80 dBA at 1 m.

.9 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 keypad.

.11 Transient voltage protection.

.12 Provide three (3) dry “C” type contacts programmable for any combination of the following:

.1 Running (output frequency being generated).

.2 Fault lockout.

.3 Stopped.

.4 At speed.

.5 Under speed.

.6 Forward/Reverse.

.7 Low reference.

.8 Manual/Auto Mode.

.9 Local/Remote Mode.

.13 Soft start sequence.

.14 Regenerative braking.

.15 Minimum of three (3) skip frequencies.

.16 Provide Hand/Off/Auto selector switch. Keypad HOA is not an acceptable replacement.

.17 Password protection of parameter programming or some method to prevent unauthorized changes.

.18 Output speed monitoring signal to be selective between 4-20 mA. or 0-10 volt.

.19 Data communication link.

.1 Data communication links shall be provided with various components in the electrical distribution system as defined in various Section of this Division and as shown on drawings. The data communication link shall Ethernet/IP.

.1 Motor control data communication link.

.2 Each variable frequency drive shall be provided with Ethernet data communication link capable of communicating with the DSC System.

.10 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.

.11 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.

.12 Cooling System:

.1 VFD supplier to provide adequate proven cooling devices for VFD equipment.

.2 VFD supplier 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.

.13 Normal Distribution

.1 Normal power distribution is subject to voltage surges and sags as a normal condition of operation. Design and supply with each VFD the required inverter protection such that the VFD will not be stressed or damaged, in the following conditions:

.1 Line transients of up to 3,000 volts with energy levels of 50 joules.

.2 Line surges of up to 115% of rated voltage for up to 10 cycles. Based on 347/600 Volt systems.

.3 Line voltage sags down to 85% of rated voltage of up to 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 will provide the VFD manufacturer and as built of each motor application. Motor application data will include at a minimum, the following:

.1 Motor manufacturer.

.2 Class.

.3 Motor model number.

.4 Motor serial number.

.5 Motor frame.

.6 Motor horsepower (hp).

.7 Motor full load amps.

.8 Motor conductor size.

.9 Ground conductor.

.10 Length of conductors from VFD to Motor.

.11 Motor MCP or fuse and overload.

.2 Installation

.1 Identify mounting requirements and include all materials and labour, including concrete pads for all floor-mounted equipment.

.2 Install VFD(s) in locations as indicated on drawings, and connect up all necessary wiring. All VFD(s) are to be mounted as close to the motor as possible. Follow manufacturer's recommendations for maximum distance between the VFD and the motor. The minimum clearance in front of VFDs is 1 m. Where required, install longlead motor package.

.3 Division 17 shall extend analog input signal cable, analog speed indicating output cable, shutdown contact and drive fault contact from the drive to the DCS System. Analog cable shall be No. 16 shielded twisted pair cable. Control wiring shall be run in conduit separate from VFD supply and motor feeder conduits.

.4 Contractor shall connect all interlocks including (but not limited to) vibration switch, freeze stats, and fire alarms to the VFD. These interlocks will be active in both the Hand (local) and Auto (remote) configurations.

.5 Contractor shall ensure that all control and stop commands shut down the drive as per manufacture's recommended procedure (example, ramp to stop, ramp and hold, or coast to stop). Contactors on the line or load side of the drive are not an approved method of control.

.6 MCC disconnect switch, VFD and motor isolation switch are to be labelled with proper shutdown procedures as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

.7 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 Prime Contractor 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 two (2) year 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 Variable Frequency Drive Check-list

.1 Upon the award of the Contract to the successful Contractor, the Prime Contractor will furnish a VFD checklist that is to be completed and submitted with the VFD shop drawings. An example of the VFD checklist is attached to this specification section.

.5 Software

.1 Provide VFD programming / troubleshooting software to City.

.2 Provide VFD Parameter list "as programmed during commissioning" for each VFD.

.6 VFD Shop Drawings.

.1 The shop drawings for each type/size of VFD must be specific to that unit. Generic shop drawing shall not be acceptable. The shop drawings are to include dimensions and physical details of the cabinets, a wiring diagram and a ladder diagram showing both internal connections and terminals for field wiring. Separate diagrams are required for each VFD/motor functions. Generic diagrams shall not be acceptable.

.2 Provide labels/lamacoids on each VFD, MCC disconnect, isolation switch as follows:

"Caution"

"* Ensure VFD is stopped before operating this switch"

"* Record all faults before resetting"

.3 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

16815. INSTALLED VFD TEST

VFD EQUIPMENT NO. _____ DATE OF TEST _____

DRIVEN MOTOR EQUIPMENT NO. _____

DRIVEN LOAD CHARACTERISTIC: CONSTANT TORQUE _____

VARIABLE TORQUE _____

SETPOINTS:
MINIMUM FREQUENCY _____ Hz

MAXIMUM FREQUENCY _____ Hz

ACCELERATION TIME _____ Sec

DECELERATION TIME _____ Sec

SPEED RANGE: MANUAL ____ RPM, _ RPM
CDACS _____ RPM, _ RPM

VFD CURRENT AT FULL LOAD: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR CURRENT: PH.A. _____ Amp, PH.B _____ Amp, PH.C _____ Amp.

MOTOR NAMEPLATE DATA:

MFR.: _____ MFR. TYPE _____ FRAME _____ hp _____
VOLTS: _____ PHASE _____ RPM _____ SERVICE FACTOR _____

AMPS _ FREQ. _ Hz AMBIENT TEMP. RATING _____ °C

TIME RATING _____ DESIGN LETTER _____

kVA CODE LETTER _ INSULATION CLASS _____

CERTIFIED _____ Date _____
Contractor's Representative

WITNESSED _____ **DATE** _

MOTOR CONTROL CENTRE

1. GENERAL

1.1 Related Work

.1 Motor Starters to 600 Volt: Section 16811

.2 Connections to Mechanical Equipment: Section 16950

1.2 References

.1 Canadian Standards Association CAN/CSA-Q9000, Quality Management and Quality Assurance Standards - Guidelines for Selection and Use.

1.3 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements. and Division 1

.2 Indicate:

.1 Outline dimensions.

.2 Configuration of identified compartments.

.3 Floor anchoring method and dimensioned foundation template.

.4 Cable entry and exit locations.

.5 Dimensioned position and size of busbars and details of provision for future extension.

.6 Schematic and wiring diagrams.

1.4 Operation and Maintenance Data

.1 Provide operation and maintenance (O&M) data for motor control centre (MCC) for incorporation into manual specified in Section 16010 - Electrical General Requirements.

.2 Include data for each type and style of starter.

1.5 Maintenance Materials

.1 Provide maintenance materials in accordance with Section 01300 – Submittals, Operation and Maintenance Manuals.

.2 Provide Spare Parts as recommended by the manufacturer.

1.6 Source Quality Control

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000.

2. PRODUCTS

2.1 Supply Characteristics

.1 600 V, 60 Hz, delta connected, 3 phase, 3 wire, grounded.

2.2 General Description

.1 Compartmentalized vertical sections with common power busbars.

.2 Metal enclosed, free standing, enclosed dead front.

.3 Indoor Electrical and Electronic Manufacturer’s Association of Canada (EEMAC) type 1A gasketted enclosure, front mounting.

.4 Class I Type B.

.5 Pre Approved: Square D, Siemens, Allen-Bradley, Eaton Cutler-Hammer.

2.3 Vertical Section Construction

.1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.

.2 Each vertical section divided into compartment units, minimum 305 mm high, as indicated.

.3 Each unit to have complete top and bottom steel plate for isolation between units.

.4 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of MCC, isolated from busbars by steel barriers.

.5 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections, and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.

.6 Openings, with removable coverplates, in side of vertical sections for horizontal wiring between sections.

.7 Incoming cables to enter at top as indicated.

.8 Provision for outgoing cables to exit via top.

.9 Removable lifting means.

.10 Provision for future extension of both ends of MCC including busbars without need for further drilling, cutting or preparation in field.

.11 Divide assembly for shipment to site, complete with hardware and instructions for re-assembly.

2.4 Sills

.1 Continuous 75 mm x 25 mm channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

2.5 Busbars

.1 Main horizontal and branch vertical, three phase high conductivity tin plated copper busbars in separate compartment self-cooled, extending entire width and height of MCC, supported on insulators and rated:

.1 Main horizontal busbars: 600 A

.2 Branch vertical busbars: 300 A.

.2 Branch vertical busbars for distribution of power to units in vertical sections.

.3 No other cables, wires, equipment in main and branch busbar compartments.

.4 Brace buswork to withstand effects of short-circuit current of 65 kA rms symmetrical.

.5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.

2.6 Ground Bus

.1 Copper ground bus extending entire width of MCC.

.2 Vertical ground bus strap, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.

2.7 Motor Starters and Devices

.1 Equip the MCC with the combination starters as specified in Section 16811 - Motor Starters to 600 V, and as shown on the drawings.

2.8 Starter Unit Compartments

.1 Units EEMAC size 5 and smaller, circuit breaker units 225 A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.

.2 Unit mounting:

.1 Engaged position - unit stabbed into vertical bus.

.2 Withdrawn position - unit isolated from vertical bus but supported by structure.

.3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.

.4 Stab-on connectors free floating tin plated clips, self-aligning, backed up with steel springs.

.3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for one (1) and four (4) padlocks to lock operating handle in "off" position and lock door closed.

.4 Hinge unit doors on same side.

.5 Overload relays manually reset from front with door closed.

.6 Pushbuttons and indicating lights mounted on door front.

.7 Devices and components by one manufacturer to facilitate maintenance.

.8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.

2.9 Wiring Identification

.1 Provide wiring identification in accordance with Section 16010 - Electrical General Requirements.

2.10 Equipment Identification

.1 Provide equipment identification in accordance with Section 16010 - Electrical General Requirements.

.1 MCC main nameplate: size No. 7, engraved as indicated.

.2 Individual compartment nameplates: size No. 5, engraved as indicated.

2.11 Finishes

.1 Apply finishes in accordance with Section 16010 - Electrical General Requirements.

.2 Paint MCC exterior light grey and interiors white.

3. EXECUTION

3.1 Installation

.1 Set and secure MCC in place on channel bases, rigid, plumb and square to building floor and wall.

.2 Make field power and control connections as indicated.

.3 Ensure correct overload heater elements are installed.

.4 Some re-arrangement of compartments is permitted from that indicated to suite manufacturer’s standards, provided that re-arrangement given approximately the spaces shown on the drawings. Submit arrangement drawings to the Contract Administrator before starting detailed drawings.

.5 Coordinate concrete pad with bevelled edges as shown on the drawings, sized to suit MCC, install and level channel sills and mount MCC.

.6 Provide control centres with vertical sections, each 2286 mm high, 508 m deep and 508 mm wide, assembled into a group having a common power bus and forming an enclosure to which additional sections may be readily added.

.7 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.

.8 Sections with horizontal wiring spaces top and bottom and with 102 mm full height vertical wiring spaces with cable tile supports. Insulate wireways from horizontal and vertical bus.

MOTOR CONTROL CENTRE

.9 Incorporate starters, circuit breakers, panels, etc. as detailed. Provide shop drawings for review before commencing fabrication.

.10 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all bus work.

.11 For each section of structure, provide a 3 phase horizontal bus rated as shown, and a 3 phase vertical bus rated 300 amperes. Tin plate vertical and horizontal bus at each joint. Provide a continuous copper ground bus in bottom of each section. where indicated on MCC schedule, provide fully rated neutral. Bus shall be copper with labyrinth design insulation - isolation for vertical bus.

.12 Contain each complete control device within an individual metal enclosure complete isolated from all other equipment. Provide plug-in type units.

.13 Provide tin-plated copper busbar stabs reinforced with strong spring steel to ensure high contact pressure.

.14 Equip door of each individual unit with a removable plate replaceable with similar plate complete with pushbuttons, pilot lights or selector switches as required. Use pilot lights of push-to-test type and push button of heavy-duty oil tight construction.

.15 Provide appropriate flanges and bus connections for incoming line and feeders.

.16 All joints and connections to be tin plated, cadmium plate all bolts, nuts and lock washers to resist corrosion.

.17 Provide pull apart terminal block plug in each starter for all external control connections, such that each starter unit may be easily removed. All terminals shall be identified.

.18 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or spaced are provided. Barriers shall also provide phase-to-phase isolation of the vertical bus.

.19 Complete control wiring diagrams for each starter with conductor identification clearly shown shall be affixed to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC.

.20 MCCs shall be fitted with on main 600 V / 120 V control transformer of sufficient V.A. capacity to handle the control requirements of the whole unit plus capacity for external control devices.

.21 Primary and secondary high rupturing capacity (HRC) fusing shall be installed on the control transformer.

.22 Each MCC containing three (3) or more vertical sections shall contain a control terminal section consisting of one full stack in height and depth. It shall be barriered from the adjacent 600 volt section. The control terminal section shall be complete with a solid back pan at the rear for the installation of control terminals.

.23 Control wiring shall be extended from each starter module to the control terminal section, including all auxiliary contacts. A multi unit style terminal block having screw type terminal connections shall be installed on standoff supports on back plate.

.24 All terminals shall be number coded or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.

3.2 Starter Verification

.1 Field check motor starters supplied prior to commissioning equipment. As a minimum, verify the following:

.1 Check of control circuits.

.2 Verify that overload relay installed in 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 motors, provide special overload relays to suit the start-up condition. Provide manufacturers' curves and data sheets where necessary to provide supporting data for motor protection.

3.4 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of MCC during an eight (8) hour period.

END OF SECTION

CONTROL DEVICES

1. GENERAL

1.1 Work Included

.1 Control equipment such as (a) pushbutton stations, indicating lights, control and relay panels, are provided under this specification to form complete control system in conjunction with (b) starters, and (c) items provided under Division 15 for example, pressure flow, float, solenoid valves, panels, pneumatic electric switches, transducers, duct and space thermostats except heating systems. Some or all of preceding items are interconnected under Part 3 of this specification. Specify control components and assemblies, relative work and interface between Divisions 15 and 16. Ensure Work required to be performed is indicated on layout drawings, diagrams, and motor starter and control list.

1.2 Shop Drawings

.1 Submit shop drawings in accordance with Section 16010 - Electrical General Requirements.

.2 Include schematic, wiring, interconnection diagrams.

2. PRODUCTS

2.1 AC Control Relays

.1 Convertible contact type: contacts field convertible from normally open (NO) to normally closed (NC), electrically held, solid state timer. Coil rating: as required. Contact rating: as required.

.2 Sealed contact type: electrically held with required poles and front mounted contact block to provide additional poles. Coil rating: as require. Contact rating: as required.

.3 Fixed contact plug-in type: general purpose with required poles. Coil rating: as required. Contact rating: as required.

2.2 Relay Accessories

.1 Standard contact cartridges: NO - convertible to NC in field.

2.3 Solid State Timing Relays

.1 Construction: AC operated electronic timing relay with solid-state timing circuit to operate output contact. Timing circuit and output contact completely encapsulated to

protect against vibration, humidity and atmospheric contaminants.

.2 Operation: on-delay or off-delay.

.3 Potentiometer: Self-contained to provide time interval adjustment.

.4 Supply voltage: 120 V, AC, 60 Hz.

.5 Temperature range: minus 20°C to 60°C.

.6 Output contact rating: maximum voltage 300 V AC or DC. Current: EEMAC B300.

.7 Timing ranges: minimum 0.1 s, maximum 60 s.

2.4 Instantaneous Trip Current Relays

.1 Enclosure: Canadian Standards Association (CSA) Type 1.

.2 Contacts: NO, NC automatic reset with adjustable tripping point.

.3 Control: 3 wire, with provision for shorting contacts during accelerating period of motor.

.4 Contact rating: Electrical and Electronic Manufacturers Association of Canada (EEMAC) B600.

2.5 Operator Control Stations

.1 Enclosure: CSA Type 1 or 4 as required, surface mounting:

2.6 Pushbuttons

.1 Illuminated, Heavy duty Oil tight. Operator flush type, as indicated. Green, with 1-NO and 1-NC contacts rated at as required, labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position labelled "emergency stop".

2.7 Selector Switches

.1 [(Maintained), 2 or 3 position labelled as indicated] heavy-duty oil tight, operators wing lever, contact arrangement as indicated, rated as required.

2.8 Indicating Lights

.1 Heavy-duty Oil tight, transformer light emitting diode (LED) type, push-to-test, lens colour: as indicated, supply voltage: as required, lamp voltage: as required, labels as

indicated.

2.9 Control and Relay Panels

.1 CSA Type 2 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.10 Control Circuit Transformers

.1 Single phase, dry type.

.2 Primary: 600 V, 60 Hz ac.

.3 Secondary: 120 V, ac.

.4 Rating: 150 VA min.

.5 Secondary fuse as required.

.6 Close voltage regulations as required by magnet coils and solenoid valves.

3. EXECUTION

3.1 Installation

.1 Install pushbutton stations, control and relay panels, control devices.

3.2 Field Quality Control

.1 Perform tests in accordance with Section 16980 - Testing, Adjusting and Balancing of Electrical Equipment and Systems.

.2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at a time and check out operation of section.

.3 Upon completion of sectional test, undertake group testing.

.4 Check out complete system for operational sequencing.

.5 Submit to Contract Administrator one copy of test results.

END OF SECTION

CONNECTIONS TO MECHANICAL EQUIPMENT

1. GENERAL

1.1 Related Work

.1 Mechanical: Division 15

1.2 Requirements

.1 Provide a complete system of wiring to motors and controls as specified herein and as shown on the drawings.

.2 Unless specifically noted otherwise, wire and leave in operation all electrically operated equipment supplied under all contracts related to this project. Examine the drawings and shop drawings of all Divisions for the extent of electrically operated equipment supplied under other contracts.

.3 All control-wiring diagrams shown on the drawings illustrate typical control circuits applicable to the equipment. Control circuits may vary with different manufacturers of equipment. Verify all control circuits with the suppliers of the equipment and make any corrections that may be required.

.4 Unless specifically noted otherwise, supply all pushbuttons, relays, starters, etc., necessary for the operation of equipment. Check all starters, relay coils and thermal elements to ensure that they provide the necessary protection for motors.

.5 Do not operate motors and controls until approval is obtained from the trade providing equipment.

.6 Examine drawings and shop drawings of other Divisions to obtain exact location of motors and equipment shown on drawings. Where necessary, obtain conduit locations from other trades' drawings and shop drawings.

.7 Assist in placing in operation all mechanical equipment having electrical connections.

.8 Provide all power wiring for all motors and control wiring as indicated on the drawings.

.9 In general, wiring for freezestats, firestats, E.P. switches, P.E. switches, dampers, temperature controllers, flow switches, solenoid valves, etc., for heating ventilating and air conditioning (HVAC) equipment will be part of Division 17. Where 120 volt power is required for mechanical equipment, i.e., roll type filters, refrigerated aftercoolers, control cabinets, etc. wiring to the equipment terminals is the Work of this Division.

.10 Refer to Motor Control Equipment Schedule.

2. PRODUCTS

2.1 3 Phase Motor Disconnect Switches

.1 Industrial Type "A", having quick make, quick break visible blade mechanism, cover interlocks and padlocking switch in the closed or open position. Use Canadian Standards Association (CSA) 2 enclosures for indoor and CSA 3 for outdoor installation. Switches to be H.P. rated, Westinghouse heavy-duty type.

2.2 120 Volt, 1 Phase Disconnect Switches

.1 Manual starter without overload relay.

2.3 208 Volt, 1 Phase Motor Disconnect Switches

.1 Manual starter without overload relay.

3. EXECUTION

3.1 Installation

.1 Provide disconnect switches adjacent to all motors.

.2 Provide all wiring between all force flow and unit heaters and their thermostats. Install wiring between all flow switches and valve monitors and the fire alarm panel.

.3 Do control wiring as indicated on the drawings and the motor control schedules.

END OF SECTION

STARTING OF ELECTRICAL EQUIPMENT AND SYSTEM

1. GENERAL

1.1 Related Work

.1 Testing, Adjusting, and Balancing of Electrical Equipment and Systems: Section 16980

.2 Electrical Equipment and Systems Demonstration and Instruction: Section 16990

1.2 Coordination

.1 Coordinate starting of electrical equipment and systems with testing, adjusting, and balancing, and demonstration and instruction of:

.1 Electrical equipment and systems specified in Division 16.

.2 Mechanical equipment and systems specified in Division 15.

.3 Other equipment and systems specified in other Divisions.

.4 City supplied UV disinfection equipment.

.5 City supplied Water Level Sensors.

.2 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such work has been completed prior to starting of electrical equipment and systems.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Energizing Electrical System

.1 Prior to energizing the new electrical system:

.1 Verify supply authority voltage and phase rotation.

.2 Close and open all devices to ensure proper mechanical operation.

3.2 Starting Motors

.1 Prior to starting motors:

.1 Confirm motor nameplate data with motor starter heater overloads.

3.3 Energizing Equipment

.1 Prior to energizing equipment provided under other Sections and equipment provided by the City, confirm equipment nameplate with characteristics of power supply.

END OF SECTION

TESTING, ADJUSTING AND BALANCING OF ELECTRICAL EQUIPMENT AND SYSTEMS

1. GENERAL

1.1 Intent

.1 Except where otherwise specified, arrange and pay for testing, adjusting, balancing and related requirements specified herein.

.2 If test results do not conform to applicable requirements, repair, replace, adjust or balance equipment and systems. Repeat testing as necessary until acceptable results are achieved.

.3 Provide all labour, materials, instruments and equipment necessary to perform the tests specified.

.4 All tests shall be witnessed by persons designated by the City, who shall also sign the test documentation.

.5 Submit procedures proposed in writing for approval two (2) weeks prior to test.

1.2 Related Work

.1 Electrical General Requirements: Section 16010

.2 Starting of Electrical Systems and Equipment: Section 16960

1.3 Manufacturer's Production Test Records

.1 If requested, submit copies of production test records for production tests required by Electrical and Electronic Manufacturer’s Association of Canada (EEMAC) and Canadian Standards Association (CSA) standards for manufactured electrical equipment.

1.4 Site Testing Reports

.1 Log and tabulate test results on appropriate test report forms.

.2 Submit forms to Contract Administrator for approval prior to use.

.3 Submit completed test report forms as specified, immediately after tests are performed.

1.5 Reference Documents

.1 Perform tests in accordance with:

.1 The Contract Documents.

.2 Requirements of authorities having jurisdiction.

.3 Manufacturer's published instructions.

.4 Applicable CSA, Institute of Electrical and Electronic Engineers (IEEE), Insulated Power Cable Engineers Association (IPCEA), EEMAC and American Society for Testing and Materials (ASTM) standards.

.2 If requirements of any of the foregoing conflict, notify Contract Administrator before proceeding with test and obtain clarification.

1.6 Manufacturer's Site Services

.1 Arrange and pay for the site services of appropriately qualified manufacturer's representatives where site testing, adjusting, or balancing of electrical equipment or systems' performed by Manufacturer's representatives is:

.1 Specified, or

.2 Otherwise required to ensure that electrical equipment and systems are operational in full compliance with the Contract Documents.

1.7 Sequencing and Scheduling

.1 Except where otherwise specified, perform all testing, adjusting, balancing and related requirements specified herein prior to Interim Acceptance of the Work.

.2 Perform voltage testing and adjusting after user occupancy or utilization of facility.

2. PRODUCTS

2.1 Test Equipment

.1 Provide all equipment and tools necessary to perform testing, adjusting and balancing specified herein and as otherwise required.

3. EXECUTION

3.1 Testing of Wiring and Wiring Devices

.1 All power and control wiring shall be tested for insulation resistance value with a 1000 volt megger. Resistance values shall be as recommended by cable manufacturer. Test results shall be properly tabulated, signed, dated and submitted with maintenance manuals.

.2 Test service grounding conductors for ground resistance.

.3 Test all wiring devices for correct operation.

.4 Test all receptacles for proper polarity and circuitry.

3.2 Ground Resistance Testing

.1 Measure ground resistance with earth test meter to verify compliance with CSA C22.2 No. 0.4 and Canadian Electrical Code.

3.3 Load Balance Testing

.1 Perform load tests when as many loads as possible, prior to Interim Acceptance of the Work, are operable.

.2 Turn on all possible loads.

.3 Test load balance on all feeders at distribution centres, motor control centre and panelboards.

.4 If load balance exceeds 15%, reconnect circuits to balance loads.

3.4 Voltage Testing and Adjusting

.1 Test voltage at all panelboards.

.2 Adjust transformer tap settings to compensate for under-voltage or over-voltage conditions, if directed to do so by Contract Administrator.

3.5 Testing of Transformer

.1 Each transformer shall be completely factory tested and the results certified, proving the performance of the units to provide capacities as listed in these specifications.

.2 Factory tests for each transformer to include:

.1 Resistance measurements of all windings.

.2 Ratio test at rated connection and on all taps.

.3 Polarity and phase relation tests.

.4 Audible sound level tests.

.5 No load loss at rated voltage and losses at 25%, 50%, 75% and 100% load.

.6 Exciting current at rated voltage.

.7 Impedance.

.8 Applied potential test.

.9 Induced potential test.

.10 95 kV B.I.L. test.

.11 Hi-pot test.

.12 Heat run, temperature rise tests on each transformer.

.3 Submittals

.1 Submit for review, shop drawings of all items specified in this section in accordance with "Shop Drawings" in the General Conditions.

.2 At completion of Work the prior to final acceptance, provide maintenance manuals for all items specified in this section.

3.6 Coordination and Short Circuit Study

.1 Provide a coordination/protective system study and short circuit study of all equipment specified herein and submit for review. Refer to Section 16405.

3.7 Calibration and Verification

.1 Description

.1 Calibrate and verify the following equipment items supplied under this contract:

.1 Primary switchgear.

.2 5 kV 600 V Dry Type Transformers.

.3 480 and 600 V switchgear.

.2 The calibration and Verification shall be carried out in the field after installation and connection of equipment, but prior to energization, in the presence of the City and the Contract Administrator.

.3 Related Work in Other Sections

.1 Unit substation to 15 kV: Section 16311

.2 Coordination and Short Circuit Study: Section 16405

.4 Submittals

.1 Submit details of all test procedures and instruments, together with technicians' names, to the Contract Administrator, prior to proceeding.

.2 Submit written verification report after installation is completed to reflect as-built conditions.

.5 Qualification

.1 Work shall be performed by a firm specializing in and with relevant experience in testing 15 kV and 600 V switchgear and protective relaying.

.2 This firm shall also perform the final checkout and testing of the equipment specified in Item 3.7 of this Section.

.6 Products

.1 Not applicable.

.7 Calibration and Verification

.1 The calibration and verification shall be carried out in the following stages:

.1 Primary switchgear.

.2 5 kV Unit Substation Transformer.

.3 600 V switchgear.

.2 The Electrical Contractor shall advise well in advance when each stage is ready for the calibration and verification and he shall:

.1 Ensure that all equipment is installed, connected and cleaned inside and out.

.2 Provide 120 V convenience receptacles.

.3 Provide one (1) qualified electrician to assist in the calibration and verification.

.4 Provide all other facilities, equipment and personnel as reasonably required to assist in the calibration and verification.

.3 For each circuit breaker, calibrate all protective relays and overcurrent device time and instantaneous trips in accordance with requirements of the protected equipment and overall coordination scheme. Field set each relay according to the recommend settings.

.4 Verify all transformer ratios, insulation values, fuse sizes, C.T. and P.T. ratios, etc. and certify that the installation is in accordance with the requirements of the manufacturer and the Coordination/Short Circuit Study. Submit a written report on this verification to the Contract Administrator.

.5 Carry out the tests required of calibration and verification firm as specified in the other related sections.

.6 Ensure all bus and cable connections are tightened to manufacturer's specifications.

.7 All relays are to be cleaned with dry, dust fee compressed air.

END OF SECTION

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

1. GENERAL

1.1 Intent

.1 Provide demonstration and instruction sessions to familiarize the City's operation and maintenance (O&M) personnel with electrical systems and their O&M.

.2 Submit system sign off sheets for each system listed prior to substantial completion.

.3 Complete a motor survey sheet for each motor and submit prior to substantial completion. Include a control-wiring diagram for each motor neatly drawn in ladder form. Indicate all terminal and wire numbers. Identify all associated control components. Provide typed copies of these lists and diagrams in the O&M manuals. Include motor overload selection charts for each type and application of overload relay.

.4 All sign off and survey sheets shall be typewritten.

1.2 Manufacturer's Site Services

.1 Arrange and pay for appropriately qualified manufacturers' representatives to provide or assist in providing electrical equipment and system demonstration and instruction as specified herein.

1.3 Contractor/City Coordination

.1 City will chair demonstration and instruction sessions.

.2 Establish agendas for demonstration and instruction sessions in conjunction with City. Coordinate scheduling of sessions with City.

2. PRODUCTS (NOT APPLICABLE)

3. EXECUTION

3.1 Systems Demonstration

.1 Demonstrate operation of the following systems:

.1 5 kV Unit Substation.

.2 600/347 V Electrical System.

.3 208/120 V System.

.4 Mechanical Equipment Connections and Controls (including interface with the fire alarm system).

MOTOR SURVEY SHEET

Motor Name & Number _____

Manufacturer_____

H.P. _____ Max. Ambient _____ °C

R.P.M. _____ Service Factor _____

Volts _____ / _____ /_____ Insulation Class _____

AMPS _____ / _____ /_____ EEMAC Design_____

PHASE _____ Time Rating_____

Frame _____ Type_____

Serial #

Model # _____

Starter _____ Type _____

OPERATING CONDITIONS

Full Load Operating Amps _____ A _____B _____ C

Full Load Operating Voltage _____ A-B _____B-C _____ C-A
at Motor

Overload Relay Installed_____ Adjustable Setting _____%

M.C.P. AMPS _____ Adjustable Setting _____

Acceleration Time (If over 5 seconds) _____

Reduced Voltage Starter Tap Setting _____

Reduced Voltage Starter Transition Time Setting _____

ELECTRICAL EQUIPMENT AND SYSTEMS
DEMONSTRATION AND INSTRUCTION

Special Controls and Remarks (Thermistor and Relay Type, Capacitors and where connected, etc.

_____

_____

ELECTRICAL EQUIPMENT AND SYSTEMS DEMONSTRATION AND INSTRUCTION

SYSTEM COMPLETION AND COMMISSIONING

SYSTEM: _____

The above system is installed as per the drawings and specifications, is complete and has been commissioned.

Electrical Contractor

Signed by: _____ Dated: _____

General Contractor

Signed by: _____ Dated: _____

Deficiencies Attached ZD?
@DY

This system has been reviewed by:

The Contract Administrator

Signed by: _____ Dated _____

The City's personnel have been instructed in the operation and maintenance of the above system:

The City

Signed by: _____ Dated _____

The above does not constitute a waiver of any of the requirements of the Contract Documents.

	ELECTRICAL CONTRACTOR	GENERAL CONTRACTOR
	_____	_____
Address:	_____	_____
	_____	_____
	_____	_____
Phone:	_____	_____

END OF SECTION

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DIVISION 17

TABLE OF CONTENTS

DIVISION 17

Reviewed and Approved

Date

1. GENERAL

1.1 Requirements of Work

.1 Supply, install, commission, provide warranty and fully document a complete instrumentation and control (I&C) system as shown on the Drawings and as specified herein. The I&C system contains vendor component subsystems specified in this and other Sections of the Specification.

.2 Component subsystems of the I&C system will include, but are not limited to, the following:

.1 Primary elements and transmitters

.2 Final control elements

.3 I&C field devices

.4 I&C junction boxes and marshalling panels

.5 Instrumentation cabling

.6 Instrumentation power supplies

.7 Conduit and cable tray

.8 Ultraviolet (UV) control panel including ABB S800 Control System hardware and communication network

.3 The Contractor's responsibility also includes receiving, uncrating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems.

.4 Where packaged, stand-alone control systems are supplied under other Divisions of this Specification, provide cabling to connect to the required remote monitoring and/or control functions. Provide end-to-end Commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.

.5 Documentation referred to in 1.1.1 to include as a minimum:

.1 Equipment descriptive data

.2 Equipment installation, service manuals, operation and maintenance (O&M) manuals and recommended spare parts lists

.3 Schematics and interconnecting wiring diagrams

.4 Records of conductor identification, field terminals, changes, etc.

.5 Instrumentation and control panel Shop Drawings, face layouts, schematics and point-to-point wiring diagrams

.6 Records of as-built information for the complete instrumentation system.

.6 Documentation provided is formatted as follows:

.1 *Piping & Instrumentation Diagrams (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* – an 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 (I/O) Index* – an index of the control system I/O points shown on the P & IDs, giving the supporting documentation as per the instrument index.

.4 *Instrument Specification Sheets* - detail the relevant data for the supply of devices.

.5 *Instrument Loop Diagrams (ILDs)* – show typical interconnections and hook-up of devices. The Contractor is to reproduce an ILD for each device and record all relevant as-built information on each sheet for submission at the completion of the Work. Fill in all terminal and wiring numbers etc. from the Shop Drawings as they become available. A set of 'B' size (11 x 17) ACAD Drawings and associated files will be made available to the successful tenderer. Where an ILD is not shown for wiring of simple devices provide a legible sketch for as-built information.

.6 *Location Drawings* - indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the Contractor in estimating the amount of cable and ducting required.

.7 *Standard Details* – provide a reference for installation, operation and other instructions pertinent to a particular device.

.8 *Detailed Specification* – lists qualifications, quality of materials and workmanship, and supplementary information.

.7 Definitions

.1 Interpret specialized terms not explicitly defined herein in accordance with The Instrumentation, Systems, and Automation Society (ISA) S51.1, National Electrical Manufacturers Association (NEMA) ICS 1, American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

.8 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 Sections 1 Through 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
Reference	**Title**
ISA S18.1-79	Annunciator Sequences and Specifications
ISA S51.1-79	Process Instrumentation Terminology
NEMA 250-85	Enclosures for Industrial Controls and System
NEMA ICS 1-88	General Standards for Industrial Control 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

.9 Related Work

.1 Process: Division 11

.2 Mechanical: Division 15

.3 Electrical: Division 16

.10 Qualifications

.1 The instrumentation Subcontractor shall be a firm normally engaged and fully competent in the type of Work described in this Section of the Specification. The firm shall have been continuously and successfully engaged in this business for at least five (5) years.

.2 Submit, in accordance with B10.2, a list of similar projects recently completed and resumes of the personnel proposed for the project. Resumes shall include evidence of journeyman status and CET registration.

.3 The instrumentation Subcontractor must be experienced in the process and instrument requirements of this Contract.

.4 The instrumentation Subcontractor must show that it maintains a fully equipped and qualified organization, capable of performing the present Work and of providing warranty service to the system after installation.

.5 Perform all instrument hook-ups, calibrations and checkouts with qualified journeyman instrument mechanics that are licenced and have CET registration. Instrument mechanics must be familiar with the devices being installed.

.6 Perform all control wiring installation and connections with qualified journeyman electricians.

.11 Codes, Rules, Permits & 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.

.4 Furnish a certificate of final inspection and approvals from an inspection authority to the Contract Administrator.

.12 Standards of Workmanship

.1 Execute all Work in a manner, which will result in the completed installation presenting an acceptable appearance, to a level of quality defined in the general conditions of this Specification.

.2 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.

.3 Arrange and install Products to fit properly into designated building spaces.

.13 Unless otherwise specified or shown, install Products in accordance with the recommendations and ratings of the Product Manufacturers.

.1 Supply and execute installation of all instrumentation control tubing in accordance with Division 17.

.14 Contract Drawings and Specifications

.1 Refer to Division 1.

.2 Supply and install all items and accessories specified by the Drawings or the Specification in the quality and quantity required. Perform all operations as designated by the 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 instrumentation and control 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 Tender Submittals

.1 Submit with the Tender an equipment list indicating the type and make of all equipment and materials proposed for this project.

.2 Receiving, Storing, and Protection of Components During Construction

.1 Examine each component upon delivery to Site. Report all damage noted to the Contract Administrator prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 10°C and the space relative humidity below 50 percent.

.2 Perform a preliminary examination upon delivery to ensure that:

.1 All instrumentation and control components supplied for this project under this Section of the Specification comply with the requirements stated in the instrument Specification sheets.

.2 All instrumentation and control components supplied under other Sections of this Specification, to be connected to instrumentation and control components supplied under this Section of the Specification, comply with the requirements stated in the Contract Documents.

.3 Itemize all non-conformities noted above and forward them to the Contract Administrator. Any delays in construction resulting from the delivery to Site of non-conforming instrumentation and control components to be borne by the Contractor.

.4 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.

.5 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.

.6 Return all damaged equipment to the factory for total corrective repairs. If deemed necessary by the Contract Administrator, the 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 Site

.1 Classification of Plant Areas

.1 Refer to Division 16

1.4 Documentation

.1 Tender Submittals

.1 Submit a schedule within thirty (30) days of award of Contract to the Contract Administrator showing projected ordering and delivery dates of all Products to meet the required construction schedule. Provide all necessary information regarding ordering and delivery dates for whose delivery affects the construction schedule.

.2 Submit Shop Drawings for all Products supplied by this Division. Submit Shop Drawings for review prior to delivery of any Products or equipment to job Site and sufficiently in advance to allow ample time for checking.

.3 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, if indicated on the Drawing, 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 that, 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.

.4 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 supplier for revision, then repeat the Shop Drawing approval process before submitting them to the Contract Administrator.

.5 Manufacture of Products shall conform to Shop Drawings marked as reviewed by the Contract Administrator and returned to the Contractor.

.6 Keep one (1) complete, maintained set of Shop Drawings at the job Site during the construction period, record Site modifications.

.7 Refer to Division 1 for further information on Shop Drawing submittals.

.2 Operations and Maintenance 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.

.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 Maintenance and operating instructions for 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 his installation.

.4 A copy of all wiring diagrams complete with wire coding.

.5 Set of final reviewed Shop Drawings.

.3 Record Drawings

.1 Maintain on-site a complete set of as-built Drawings as listed in Division 1 of this Specification.

.2 In addition to the requirements as stated in Division 1, record on the Drawings the following information:

.1 Mark all change orders, alterations or additions

.2 Show all instrumentation cable and control tubing

.3 Show all changes to the numbers and location of outlets, motors, panels and end devices that may occur during the course of the Work.

.3 Before requesting the final completion certificate make any necessary final corrections to the Drawings, sign each print as a certification of accuracy and deliver all sets to the Contract Administrator for approval.

2. PRODUCTS

2.1 General

.1 Refer to the requirements of Division 1

.2 Selected Products and Equivalent

.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 those, which are to be used as the basis for the Bid.

.3 The design has been based on the use of the first named Product, where applicable equivalent Products are listed.

.4 Provide the Products specified unless a proposal for an alternative or substitute Product has been accepted by the Contract Administrator.

.3 Alternate Products

.1 Refer to Division 1 for consideration of alternate Products.

.2 Alternate Products and materials to those specified will only be considered by the Contract Administrator if they are shown in the Bid as a material variation, and if they are submitted with an appropriate price adjustment. The Contract Administrator will reserve the right to accept or reject any alternative without explanation.

.3 The alternate submission shall provide sufficient information to enable the Contract Administrator to determine whether the alternate is acceptable or unacceptable.

.4 Provide complete information on required revisions to other Work and Products to accommodate each alternate Product.

.5 The Contractor assumes full responsibility when providing alternative Products or materials that all space, weight, connections, power and wiring requirements etc. are considered and compensated for. Any costs incurred for additional components, changes to other services, structural or space requirements, layouts and plans, etc. that may arise from the use of the alternate to be borne by the Contractor.

.6 Materials or equipment rejected by the Contract Administrator to be immediately removed from the project.

.4 Review of Products

.1 Immediately after notification of award of Contract, review with the Contract Administrator the list of Products to be provided by this Division

.2 After agreement on Product list has been reached, no subsequent changes will be permitted except as specified hereafter.

.5 Substitution of Products After Contract Award

.1 After acceptance of the list of Products, no substitution of any item will be permitted unless the approved item cannot be delivered in time to comply with the Work schedule.

.2 To receive acceptance, proposed substitute Products are to equal or exceed the quality, finish and performance of those specified and/or shown, and not to exceed the physical space requirements allotted, as shown on the Drawings.

.3 Provide to the Contract Administrator documentary proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from Suppliers of both specified items and proposed substitutions.

.4 Include costs for any required revisions to other structures and Products to accommodate such substitutions.

.5 Refer to Division 1 for additional information on substitutions.

.6 Quality of Products

.1 All Products provided to be CSA Approved, and Underwriters' Laboratories of Canada 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.

.7 Uniformity of Manufacture

.1 Unless otherwise specifically called for in the Specification, uniformity of manufacture to be maintained for similar Products throughout the Work.

.8 Product Finishes

.1 Products to be Manufacturers' standard finish. Where special finishes are specified refer to Division 9 for details on quality and workmanship of the finishes.

.9 Use of Products During Construction

.1 Any equipment used for temporary or construction purposes to be approved by the Contract Administrator and in accordance with Division 1 of this Specification. Clean and restore to "as new" condition all equipment prior to the time of substantial completion.

.2 The Warranty Period does not begin until the date of Substantial Completion of the Work.

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 protectors, 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 5 mm white lettering on black 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 lamicoid 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 and field devices with a heat shrink sleeve with machine printed labeling.

.4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.

.5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.

.6 Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a room, and 13 m on centre throughout the room. This shall apply to conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels conduit identification.

.7 For direct current wiring use black for positive and white for negative.

.8 For thermistor wiring to motors use red and blue coloured, insulated wire.

3. EXECUTION

3.1 Site Examination

.1 Refer to the requirements of Division 1.

.2 No additional compensation will be given for extra Work due to existing conditions that a Site examination prior to Bid should have disclosed.

3.2 Coordination With Other Divisions

.1 Examine the Drawings and Specifications of all Divisions and become fully familiar the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any conflicting issues between Divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.

.2 Coordinate the Work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.

.3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other Division's installation Work.

.4 Lay out the Work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural Drawings take precedence over electrical Drawings regarding locations of walls, doors and equipment.

.5 Structural members shall not be cut without prior approval of the Contract Administrator.

.6 Examine previously constructed Work and notify the Contract Administrator of any conditions, which prejudice the proper completion of this Work.

3.3 Product Handling

.1 Use all means necessary to protect the Products included in this Division before, during and after installation, and to protect Products and installed Work of all other trades.

.2 Any damage to the Products and/or installed Work shall be repaired or replaced by the Contractor at no additional cost to the City, and to the approval of the Contract Administrator.

.3 Remove advertising labels from all Products installed that have such labels attached. Identification or CSA labels are not to be removed.

.4 Remove dirt, rubbish, grease, etc. resulting from Work performed under this Section of the Contract from all surfaces.

3.4 Separation of Services

.1 Maintain separation between the electrical wiring system, building piping, ductwork, and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.

.2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings are not to be used for the support of wiring.

3.5 Wire And Cable

.1 Refer to Section 17124.

3.6 Equipment Connections

.1 Prior to the connection of signal wiring to process control and instrumentation devices check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

.2 All control-wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different Manufacturers equipment. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.

.3 Provide power disconnect terminals in the marshalling panels for all devices or PLC/DCS input/outputs sourced from the panel. Provide local power disconnect switches for all 120VAC power instruments. Mount adjacent to the instrument.

.4 Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local WP junction box within approximately 3 m of cable from the transponder.

3.7 Wiring To Equipment Supplied By Others

.1 Equipment supplied by the City or by other Divisions, that have external or field mounted control devices, are to be installed, wired and commissioned by this Division.

3.8 Access Panels

.1 Provide access panels where instrumentation and control 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. The type and size of panels are to be coordinated with the Contract Administrator.

.2 In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 25 mm diameter blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.9 Instrument Mounting Stands

.1 Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum or galvanized steel.

.2 Supply and install protective drip shields for any exterior stand-mounted instrumentation equipment. Drip shields are to extend 50 mm past the front and side faces of the equipment. Drip shields are to be fabricated from aluminum.

3.10 Sealing Of Wall And Floor Openings

.1 Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.

.2 Seal openings after all wiring entries have been completed.

.3 Sealing material shall be fire resistant and shall not contain any compounds that could chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.

3.11 Sleeves

.1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.

.2 For walls, partitions and ceilings the ends shall be flush with the finish on both sides. For floors the ends shall extend 100 mm above finished floor level.

.3 Fill the space between the sleeve and the conduit with fire stop material. Caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.

.4 Locate the sleeves and position exactly prior to construction of the walls and floors.

.5 Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.12 Connections to Mechanical, Electrical and Existing Systems

.1 Refer to Division 16 for the required tie-in procedures.

3.13 Testing of Instrumentation Loops

.1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.

.2 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.

.3 Test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.

.4 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.

.5 Sign and date all test reports. Submit the test reports to the Contract Administrator within five (5) working days of testing.

.6 Coordinate and cooperate with City staff and the UV Systems Vendor to test Control system I/O points during loop testing.

3.14 Calibration

.1 Instruments to be factory pre-calibrated and the calibration verified in-place after installation. 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 1/2 of 1% of full range, or to the Manufacturer's stated accuracy of the instrument whenever an accuracy of 1/2 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.

3.15 Commissioning

.1 Refer to the requirements of Division 1 for additional Commissioning requirements.

.2 Inspections

.1 Provide two (2) weeks' written notice to the Contract Administrator prior to energizing any system to allow for inspection by the Contract Administrator of the following:

.1 Proper mounting.

.2 Proper connections.

.2 During Commissioning demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges

.3 Commissioning of the instrumentation and control system to include but not be limited to the following.

.1 Supervise 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 instruments and control equipment.

.5 Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.

.6 Instruct plant personnel in correct method of operation of instruments and control equipment.

.7 Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

.8 Ensure that the instrumentation and control equipment Suppliers cooperate to complete the Work of this Section.

.9 Verify signal levels and wiring connections to all instrumentation and control equipment.

.10 Coordinate and cooperate with City staff and the UV Systems supplier to commission Control system I/O points during equipment Commissioning.

3.16 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.

3.17 Test Forms

	Form No.	Title
.1	ITR	Instrument Test Report
.2	LCR	Loop Check Report

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 _____

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: _____

ENCLOSURES

1. GENERAL

1.1 References - General

.1 Suppliers, Equipment, Products, and Execution must meet all requirements detailed in Section 17010.

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 9.

.2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

2.2 Enclosures

.1 Provide Electrical & Electronic Manufacturer's Association of Canada (EEMAC) Type 1A gasketted enclosures in MCC rooms and control rooms.

.2 All enclosures for mounting outside of MCC rooms and control rooms to be EEMAC Type 4, watertight except where otherwise specified.

.3 Provide EEMAC 7/3R enclosures for equipment in and around classified areas such as sumps.

.4 Enclosures for certain equipment in corrosive atmospheres to be EEMAC 4X approved for the classification (e.g. chemical cleaning).

.5 Enclosures for mounting field control indicator lamps and switches in unclassified areas to be Allen Bradley model 800T-xTZ die cast enclosures.

.6 Enclosures for mounting field control indicator lamps and switches in Class 1 areas to be Allen Bradley model 800H-xHHX7 cast aluminum enclosures.

2.3 Panel Enclosures

.1 Fabricate panel enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing lineup. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.

.2 Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.

.3 Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120VAC duplex convience receptacle inside the enclosure.

2.4 Marshaling and Control Panels

.1 Supply, fabricate, checkout, layout, document and deliver to Site fully equipped and functional panels**.**

.2 Supply all components contained on or within the panels fully wired under this Section of the Specification.

.3 The Selection of all accessories, materials and methods for fabrication not covered by this Specification, but which are necessary to complete the fabrication of the control panels, is the responsibility of the panel fabricator.

.4 Marshalling and control panels shall be adequately sized to facilitate a professional, uncluttered arrangement. Provide adequate internal and external space to accommodate a 20% increase in each type of component used. Allow space for future installation of at least one (1) additional programmable logic controller (PLC) or distributed control system (DCS) rack as appropriate.

2.5 Wiring and Accessories

.1 Provide wiring inside the panels according to the following Specifications:

.1 Control wiring to be a minimum of #16 AWG tinned stranded copper; insulation rated at 600 V.

.2 Wiring for power distribution shall be a minimum of #14 AWG tinned stranded copper; insulation rated at 600 V.

.3 Refer to Division 16 for cable routing requirements.

.2 Tag each wire at both ends with a heat shrink sleeve that is machine printed.

.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 40 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 K4-PT-100A located in the field has a 2CTPSH cable connected to it. The cable runs through a junction box to a marshaling panel. The wire identifiers for the pair of wires would be K4-PT-100A all the way to the marshaling panel.

.4 Identify spare wires by using the destination identifier, i.e. the location and terminal identifier of the opposite end of the wire are combined to form the wire tag.

.7 Provide a 120 VAC panel power distribution system and a 24VDC power distribution system in each panel. Provide 12VAC power for the CCTV fiber converters as required. 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 Wieland WK4TSK/U type to isolate field wiring that is powered sourced from the panel.

.9 Provide sufficient terminals so that not more that two (2) wires are connected under the same terminal. Provide 20% spare terminal capacity at each terminal block assembly.

.10 Terminals shall be Wieland Type WK4/U color coded as follows:

Red	=	positive 24VDC
Black	=	0VDC common and 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 black lamicoid with white lettering, a minimum of 25 mm x 75 mm in size with up to three 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 marshaling panel.

.2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.

.3 Provide in each marshaling panel an isolated grounding bus bar 6 x 25 x 600 mm, equipped with necessary lugs for accepting two (2) #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, Part 3.

3.2 Mounting Heights

.1 Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 2,000 mm to top of cover.

END OF SECTION

INSTRUMENTATION CABLE

1. 1. GENERAL

1.1 Product Data

.1 Submit Product data in accordance with Division 1 and Division 16.

1.2 Related Work

.1 Refer to Division 16.

1.3 Inspection

.1 Provide adequate notice to the Contract Administrator so that all cable installations can be inspected prior to connecting equipment.

1.4 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 #18 AWG, 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 #18 AWG.

.5 Overall flame retardant polyvinyl chloride (PVC) jacket to CSA-C22.2.

.6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.

.7 Shaw Type 1751-CSA or 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 #18 AWG.

.2 PVC insulated for 600V.

.3 100% coverage aluminum foil or tape shield.

.4 Separate bare stranded copper drain wire.

.5 Overall flame retardant PVC jacket to CAS-C22.2

2.3 Teck Cables

.1 As per Division 16.

2.4 Wire

.1 As per Division 16.

2.5 Fiber Optic Cables

.1 Provide fiber optic cable assemblies where indicated in the Specification and Drawings.

.2 Fiber optic cables shall be constructed with specified quantity of 62.5/125 µm multi-mode glass fibers with individual and overall PVC jacket, spiral interlocked armour, and outer PVC jacket FT4 rated.

.3 Provide terminations for fiber optic cables including; buffer tube fan out kits, connectors, termination panels, and wall mount enclosure.

.4 Provide fiber optic jumpers 62.5/125 µm multi-mode for inter-cabinet connections.

3. EXECUTION

3.1 Analog Signals

.1 Use TPSH cable for all low level analog signals such as 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under, and other signals of a similar nature.

.2 Use RTD cable for connections between RTDs and transmitters or control system RTD inputs.

3.2 Digital Signals

.1 Use TPSH cable for all low level input (24V and below) and output signals to the control system.

.2 Use Teck cable or wire and conduit for power to instruments, for 120V 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. Where splices are required, obtain approval from the Contract Administrator prior to installing the cable.

.5 Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes. Keep splices in instrumentation cable to a minimum and separated physically from power circuits. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

.6 Where splices are made to coaxial cables, use standard coaxial cable connectors

.7 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling panel.

.8 Protect all conductors against moisture during and after installation.

3.4 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 Terminations of fiber optic cables shall be performed by factory trained technicians with appropriate tools and testing equipment.

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.

.2 Test all fiber optic cables and terminations for signal integrity and Manufacturer's Specifications.

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 or equivalent.

END OF SECTION

POWER SUPPLIES

1. 1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

2. 2. PRODUCTS

2.1 Power Supply and Conditioning Equipment

.1 General

.1 Provide all DC power supplies as required for all instrument circuits. All circuits to be powered from the marshalling panels. Power supplies to be equal to Hammond or G.F.C., complete with an overvoltage 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 2 circuits as defined under Section 16 of the Canadian Electrical Code (CEC) Part I.

.4 Unless otherwise required, all DC power supplies to be rated 28VDC, 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 2 amps.

2.2 Noise Suppression

.1 Provide power conditioners in each panel to power AC instrumentation and control loads. Power conditioners are Oneac Series CX.

2.3 UPS Power Supply

.1 Provide an uninterruptible power supply (UPS) in each panel to power the control system equipment.

.2 Provide a UPS for each computer workstation. Connect the workstation and its associated peripherals such as network concentrators, printers, etc. to the UPS.

.3 Size UPS standby capacity for 30 minutes at full load rating.

.4 Provide on-line units from Exide, Oneac, Toshiba or Best.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

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 which 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 & Electronic Manufacturer's Association of Canada (EEMAC) 4, minimum.

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.

.2 All control indicator lamps, pushbutton switches and selector switches in classified or corrosive (includes outdoors) areas to be Allen Bradley 800H series items.

.3 Enclosures to be as specified under Section 17110.

2.3 Relays

.1 The Quality and type of relays shall be based on Omron types.

.2 120VAC relays to be Model LY 4PDT, plug-in, complete with test button and operation indicator, and surge suppressor.

.3 24VDC 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 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 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.

END OF SECTION

SIGNAL CONDITIONING MODULES

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

2. PRODUCTS

2.1 Signal Conditioning Modules

.1 Where required, provide signal conditioning modules which 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

.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 LED indicators for relay status.

.8 Modules to withstand 30 volts per meter radio frequency radiation between 200 and 500 MHz with not more than 0.25% calibration effect. Provide modules with traps on the terminals to shunt conducted radio frequency interference to ground.

.9 Galvanically isolate signal and power supply terminals from the case.

.2 All modules specified in this Section to be the Product of a single Manufacturer.

2.3 Current to Pneumatic (I/P) Converters

.1 Not used.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

END OF SECTION

PANEL INSTRUMENTS

1. GENERAL

1.1 References - General

.1 Equipment, Products and Execution must meet all requirements detailed in Section 17010.

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, LED or gas-discharge type, including bar-graph displays with not less than 200 segments. Backlit LCD indication is also acceptable.

.4 Analog signal inputs to be 4-20 mA VDC.

.5 Analog signal outputs to be 4-20 mA VDC into 500 ohms.

.6 Galvanically isolate the signal and power supply from the instrument case.

.2 Panel instruments specified in this Section are to be the Product of a single Manufacturer, and to match and line up to form an integrated appearance and operator interface strategy.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010.

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.

2. PRODUCTS

2.1 Miscellaneous Panel Devices

.1 Pilot Lights

.1 Provide pilot lights of the LED 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.

.4 Terminals to be Weidmuller or approved equal.

.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.

.6 Provide Weidmuller disconnect type terminal blocks for each load or loop powered from the marshalling panels.

.3 Nameplates

.1 Refer to Section 17010 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 National Electrical Manufacturers Association (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, 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 Type MT3042, Stahl 9005/01-252/100/00, P+F ZG series, or equal.

.2 Provide dual type intrinsic safety barriers for process switches; MTL 787, Panalarm 201-BR2.

.3 Intrinsic safety relays to be Gems, or Warrick.

2.4 Industrial Ethernet Switches

.1 Switches shall comply with Institute of Electrical and Electronic Engineers (IEEE) 802.3, 802.3u, 802.3x, 802.1D.

.2 Switches shall include a minimum of 6 10/100 Base T(x) RJ45 Ports and 2 multimode 100 Base FX Fiber ports.

.3 Switches shall include one (1) relay output alarm contact rated for 1A@24VDC.

.4 Input power shall be capable of ranging from 9 to 32 VDC with redundant inputs.

.5 Switches shall be fast spanning for a sub-second recovery in a ring configuration.

.6 Switches shall be Eagle Technology ED6008 Series or approved equal.

2.5 NTSC Fiber Transmitters/Receivers

.1 Models shall have a minimum of four (4) NTSC compliant channels and one (1) multimode fiber channel.

.2 Transmitters and receivers shall be supplied with a regulated switching power supply with a 120 VAC input.

.3 Transmitters and receivers shall be Pelco FT8304MSTR and FR8304MSTR respectively.

3. EXECUTION

3.1 References - General

.1 Refer To Section 17010, Part 3.

END OF SECTION

CONTROL AND OPERATOR INTERFACE REQUIREMENTS

1. GENERAL

1.1 General Requirements

.1 Design, supply, and installation of an ABB S8000 Remote inputs/outputs (I/O) based control system for the ultraviolet (UV) light disinfection facility that will control and monitor the system in accordance with the requirements defined by the Contract Documents.

.2 The S800 Remote I/O sub-system shall be housed in a central marshalling panel to be located in the UV Building control room.

.3 Design, supply, and installation of a control & communication network complete with all necessary interface devices, and network hardware.

.4 Cooperation with the UV Systems vendor and City staff to interface and test the new S800 based system together with the existing Distributed Control System (DCS).

.5 Start-up and Commissioning of the complete control system and associated field devices and wiring.

2. PRODUCTS

2.1 ABB S800 Remote I/O System

.1 General

.1 All new control system equipment to be based on the ABB Harmony and S800 family as applicable (no substitutions allowed).

.2 Control system logic configuration shall be done on the existing Plant DCS system by City personnel.

.3 All communication equipment required to interface to the existing Plant DCS system shall be supplied and installed. Refer to drawing CI1.01 for details).

.4 ABB S800 DI 810, 2 x 8 channel 24 VDC input modules.

.5 ABB S800 DI820 8 channel 120 VAC input modules.

.6 ABB S800 D0820, 8 channel relay output modules.

.7 ABB S800 AI820, 4 channel isolated analog input modules.

.8 ABB S800 AO820, 4 channel isolated analog output modules.

.9 Ethernet will be used to interface to all UV System PLC to the existing Plant DCS. Provide all required cabling as depicted on Drawing CI1.0.1.

.10 Provide at least 20% spare I/O of each type in each panel assembly.

.11 Provide all necessary din rail, mounting bases, power supplies, cables, communication cards, and accessories.

.12 Provide spares of all ABB S800 system components (minimum of one of each exact type) supplied including: power supplies, communication modules, and input/output modules.

.13 Provide redundant power supplies and 25% spare power supply capacity for each S800 panel assembly.

.14 Each new control 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 contacts to an S800 input point and configure as an alarm on the control system at each panel.

.15 Supply of S800 Equipment is expected to include:

.1 Control equipment free standing cabinet to mount remote S800 I/O equipment, power supplies and gateway equipment.

.2 PBA Hnet bus adapters

.3 PHBIOR80010000 Harmony S800 I/O Gateway Modules

.4 PHBIOR8000N200 S800 I/O Gateway mounting bases

.5 PHBRFO80010000 Harmony Hnet Fibre Optic repeaters

.6 PHBRMU8000N200 Harmony repeater bases

.7 Terminators for Hnet

.8 TB846 dual modulebus inlets

.9 Terminators

.10 TB820V2 modulebus cluster modems (up to 12 I/O) modules per modem)

.11 TB842 modulebus optical ports

.12 TK811V015 duplex cables

.13 SD821 power supplies

.14 AI820, 4 channel analog input modules

.15 AO820, 4 channel analog output modules

.16 DI810, 2 x 8 channel 24 VDC input modules

.17 DI820, 8 channel 120 VAC input modules

.18 DO820, 8 channel relay output modules

.19 TU838 termination units

2.2 System Integration Requirements

.1 Cooperate and coordinate activities with other Contractors, City of Winnipeg (City) staff, and consultants to facilitate installation, testing, validation, and Commissioning of the UV Light Disinfection System.

.2 Supply, install, test and commission the UV control panel UV CP1 as specified in this Division and as shown on the Drawings.

.3 Extend the existing DCS network to the S800 Remote I/O System and UV PCV station and assist the City and UV system vendor to establish communication between the UV programmable logic controller (PLC), S800 Remote I/O System and the Plant DCS. Test data exchange as defined in this Division and the process description.

.4 All equipment testing and commissioning responsibilities must be carried out while at the same time maintaining the Plant DCS. Any equipment outage requirements are to be kept to a minimum and are to be scheduled with the Contract Administrator prior to implementation.

3. EXECUTION

3.1 Performance – General

.1 Refer to Section 17010, Part 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 the Specification.

.2 Provide all necessary documentation to define the control system including details for all hardware.

.3 Commission and start up the system as defined herein.

.4 Provide all documentation and training as defined herein.

.5 Maintain existing plant operation during entire Construction Period. Refer to the requirements of Division 1.

END OF SECTION

PLC I/O INDEX

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 PLC I/O Index

.1 The following spreadsheet gives an itemized list of the inputs/outputs (I/O) between the programmable logic controller (PLC) and the field devices. It is intended to serve as an aid for determining the cabling requirements for the Work specified in this Division.

2. PRODUCTS

.1 Not used in this Section.

3. EXECUTION

.1 Not used in this Section.

END OF SECTION

CITY OF WINNIPEG
NORTH END WATER POLLUTION CONTROL CENTER
SECONDARY EFFLUENT DISINFECTION
ULTRAVIOLET PLC INPUT/OUTPUT LIST

Project No. 66303

NO.	REV. NO.	TAG NAME	DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
			FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
								LOW	HIGH		
1	0	U060-FIT	Ultrasonic Open Channel Flow Trans	UV Influent Pump Discharge Channel	PI-07					AI	
2	0	U070-UA-1	Minor Alarm	UV System	PI-07					DO	
3	0	U070-UA-2	Major Alarm	UV System	PI-07					DO	
4	0	U070-UA-3	Critical Alarm	UV System	PI-07					DO	
5	0	U110-YM	Bank On	UV System Bank 1A	PI-07					DO	
6	0	U111-AT	Ultraviolet Light Intensity	UV System Bank 1A	PI-07					AI	
7	0	U120-YM	Bank On	UV System Bank 1B	PI-07					DO	
8	0	U121-AT	Ultraviolet Light Intensity	UV System Bank 1B	PI-07					AI	
9	0	U170-LT	Liquid Level Transmitter	UV Channel 1	PI-07					AI	
10	0	U210-YM	Bank On	UV System Bank 2A	PI-08					DO	
11	0	U211-AT	Ultraviolet Light Intensity	UV System Bank 2A	PI-08					AI	
12	0	U220-YM	Bank On	UV System Bank 2B	PI-08					DO	
13	0	U221-AT	Ultraviolet Light Intensity	UV System Bank 2B	PI-08					AI	
14	0	U270-LT	Liquid Level Transmitter	UV Channel 2	PI-08					AI	
15	0	U310-YM	Bank On	UV System Bank 3A	PI-09					DO	
16	0	U311-AT	Ultraviolet Light Intensity	UV System Bank 3A	PI-09					AI	
17	0	U320-YM	Bank On	UV System Bank 3B	PI-09					DO	
18	0	U321-AT	Ultraviolet Light Intensity	UV System Bank 3B	PI-09					AI	
19	0	U370-LT	Liquid Level Transmitter	UV Channel 3	PI-09					AI	
20	0	U102-YS	Remote Control Selected	UV Channel 1 Weir Gate	PI-10					DI	
21	0	U102-ZC	Position Control Output	UV Channel 1 Weir Gate	PI-10					AO	
22	0	U102-ZSB	Closed Status	UV Channel 1 Weir Gate	PI-10					DI	
23	0	U102-ZSD	Open Status	UV Channel 1 Weir Gate	PI-10					DI	
24	0	U102-ZT	Position Transmitter	UV Channel 1 Weir Gate	PI-10					AI	
25	0	U202-YS	Remote Control Selected	UV Channel 2 Weir Gate	PI-10					DI	
26	0	U202-ZC	Position Control Output	UV Channel 2 Weir Gate	PI-10					AO	
27	0	U202-ZSB	Closed Status	UV Channel 2 Weir Gate	PI-10					DI	
28	0	U202-ZSD	Open Status	UV Channel 2 Weir Gate	PI-10					DI	

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB = Modbus

CITY OF WINNIPEG
NORTH END WATER POLLUTION CONTROL CENTER
SECONDARY EFFLUENT DISINFECTION
ULTRAVIOLET PLC INPUT/OUTPUT LIST

Project No. 66303

NO.	REV. NO.	TAG NAME	DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
			FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
								LOW	HIGH		
29	0	U202-ZT	Position Transmitter	UV Channel 2 Weir Gate	PI-10					AI	
30	0	U302-YS	Remote Control Selected	UV Channel 3 Weir Gate	PI-10					DI	
31	0	U302-ZC	Position Control Output	UV Channel 3 Weir Gate	PI-10					AO	
32	0	U302-ZSB	Closed Status	UV Channel 3 Weir Gate	PI-10					DI	
33	0	U302-ZSD	Open Status	UV Channel 3 Weir Gate	PI-10					DI	
34	0	U302-ZT	Position Transmitter	UV Channel 3 Weir Gate	PI-10					AI	

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB = Modbus

CITY OF WINNIPEG
NORTH END WATER POLLUTION CONTROL CENTER
SECONDARY EFFLUENT DISINFECTION
DISTRIBUTED CONTROL SYSTEM INPUT/OUTPUT LIST

Project No. 66303

NO.	REV. NO.	TAG NAME			DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
1	0	U	A	U005-LT	Liquid level transmitter	UV Influent Pump Well Level	PI-04	mm				AI	
2	0	U	A	U005-LF	Liquid level transmitter fault	UV Influent Pump Well Level	PI-04					DI	
3	0	U	A	U010-IIT	Current Transmitter	UV Influent Pump U-010-P-1	PI-06	Amps				AI	
4	0	U	A	U010-MM	Motor Running	UV Influent Pump U-010-P-1	PI-06					DI	
5	0	U	A	U010-MN	Start Command	UV Influent Pump U-010-P-1	PI-06					DO	
6	0	U	A	U010-SC	Speed Control Output	UV Influent Pump U-010-P-1	PI-06	%				AO	
7	0	U	A	U010-SIT	Speed Transmitter	UV Influent Pump U-010-P-1	PI-06	%				AI	
8	0	U	A	U010-UF	Pump or Drive Fault	UV Influent Pump U-010-P-1	PI-06					DI	
9	0	U	A	U010-YS	Remote Control Selected	UV Influent Pump U-010-P-1	PI-06					DI	
10	0	U	A	U020-IIT	Current Transmitter	UV Influent Pump U-020-P-1	PI-06	Amps				AI	
11	0	U	A	U020-MM	Motor Running	UV Influent Pump U-020-P-1	PI-06					DI	
12	0	U	A	U020-MN	Start Command	UV Influent Pump U-020-P-1	PI-06					DO	
13	0	U	A	U020-SC	Speed Control Output	UV Influent Pump U-020-P-1	PI-06	%				AO	
14	0	U	A	U020-SIT	Speed Transmitter	UV Influent Pump U-020-P-1	PI-06	%				AI	
15	0	U	A	U020-UF	Pump or Drive Fault	UV Influent Pump U-020-P-1	PI-06					DI	
16	0	U	A	U020-YS	Remote Control Selected	UV Influent Pump U-020-P-1	PI-06					DI	
17	0	U	A	U030-IIT	Current Transmitter	UV Influent Pump U-030-P-1	PI-06	Amps				AI	
18	0	U	A	U030-MM	Motor Running	UV Influent Pump U-030-P-1	PI-06					DI	
19	0	U	A	U030-MN	Start Command	UV Influent Pump U-030-P-1	PI-06					DO	
20	0	U	A	U030-SC	Speed Control Output	UV Influent Pump U-030-P-1	PI-06	%				AO	
21	0	U	A	U030-SIT	Speed Transmitter	UV Influent Pump U-030-P-1	PI-06	%				AI	
22	0	U	A	U030-UF	Pump or Drive Fault	UV Influent Pump U-030-P-1	PI-06					DI	
23	0	U	A	U030-YS	Remote Control Selected	UV Influent Pump U-030-P-1	PI-06					DI	
24	0	U	A	U040-IIT	Current Transmitter	UV Influent Pump U-040-P-1	PI-06	Amps				AI	
25	0	U	A	U040-MM	Motor Running	UV Influent Pump U-040-P-1	PI-06					DI	
26	0	U	A	U040-MN	Start Command	UV Influent Pump U-040-P-1	PI-06					DO	
27	0	U	A	U040-SC	Speed Control Output	UV Influent Pump U-040-P-1	PI-06	%				AO	
28	0	U	A	U040-SIT	Speed Transmitter	UV Influent Pump U-040-P-1	PI-06	%				AI	
29	0	U	A	U040-UF	Pump or Drive Fault	UV Influent Pump U-040-P-1	PI-06					DI	
30	0	U	A	U040-YS	Remote Control Selected	UV Influent Pump U-040-P-1	PI-06					DI	
31	0	U	A	U050-IIT	Current Transmitter	UV Influent Pump U-050-P-1	PI-06	Amps				AI	
32	0	U	A	U050-MM	Motor Running	UV Influent Pump U-050-P-1	PI-06					DI	
33	0	U	A	U050-MN	Start Command	UV Influent Pump U-050-P-1	PI-06					DO	
34	0	U	A	U050-SC	Speed Control Output	UV Influent Pump U-050-P-1	PI-06	%				AO	

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NO.	REV. NO.	TAG NAME			DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
35	0	U	A	U050-SIT	Speed Transmitter	UV Influent Pump U-050-P-1	PI-06	%				AI	
36	0	U	A	U050-UF	Pump or Drive Fault	UV Influent Pump U-050-P-1	PI-06					DI	
37	0	U	A	U050-YS	Remote Control Selected	UV Influent Pump U-050-P-1	PI-06					DI	
38	0	U	A	U070-UA-1	Minor Alarm	UV System	PI-07					DI	
39	0	U	A	U070-UA-2	Major Alarm	UV System	PI-07					DI	
40	0	U	A	U070-UA-3	Critical Alarm	UV System	PI-07					DI	
41	0	U	A	U110-YM	Bank On	UV System Bank 1A	PI-07					DI	
42	0	U	A	U120-YM	Bank On	UV System Bank 1B	PI-07					DI	
43	0	U	A	U210-YM	Bank On	UV System Bank 2A	PI-08					DI	
44	0	U	A	U220-YM	Bank On	UV System Bank 2B	PI-08					DI	
45	0	U	A	U310-YM	Bank On	UV System Bank 3A	PI-09					DI	
46	0	U	A	U320-YM	Bank On	UV System Bank 3B	PI-09					DI	
47	0	U	A	U900-UA-1	Fire Alarm	UV Facility Fire Alarm Panel						DI	
48	0	U	A	U900-UA-2	Trouble Alarm	UV Facility Fire Alarm Panel						DI	
49	0	U	A	U910-ZS-1	Infra-Red Motion Sensor	UV Facility Process Room						DI	
50	0	U	A	U910-ZS-2	Infra-Red Motion Sensor	UV Facility Process Room						DI	
51	0	U	A	U910-ZS-3	Infra-Red Motion Sensor	UV Facility Process Room						DI	
52	0	U	A	U910-ZS-4	Infra-Red Motion Sensor	UV Facility Process Room						DI	
53	0	U	A	U911-ZS	Infra-Red Motion Sensor	UV Facility Entrance Hall						DI	
54	0	U	A	U912-ZS-1	Infra-Red Motion Sensor	UV Facility Electrical Room						DI	
55	0	U	A	U912-ZS-2	Infra-Red Motion Sensor	UV Facility Electrical Room						DI	
56	0	U	A	U913-ZS	Door Switch	UV Facility Entrance						DI	
57	0	U	A	U914-ZS	Door Switch	UV Facility Process Room						DI	
58	0	X	X	U920-ET	Voltage	UV Facility 4160 Volt Bus A		Volts				TCP/IP	
59	0	X	X	U920-IT	Current	UV Facility 4160 Volt Bus A		Amps				TCP/IP	
60	0	X	X	U920-JT	Power	UV Facility 4160 Volt Bus A		kW				TCP/IP	
61	0	U	A	U980-ZS	Infra-Red Motion Sensor	Final Effluent Sampling Building						DI	
62	0	U	A	U981-TAL	Wet Side Heat Fault	Final Effluent Sampling Building						DI	
63	0	U	A	U982-TAL	Dry Side Heat Fault	Final Effluent Sampling Building						DI	
64	0	G	A	U002-VB	Gate close command	Sluice Gate YG-12 Actuator	PI-09					DO	
65	0	G	A	U002-VD	Gate open command	Sluice Gate YG-12 Actuator	PI-09					DO	
66	0	G	A	U002-YS	Computer selected	Sluice Gate YG-12 Actuator	PI-09					DI	
67	0	G	A	U002-ZSB	Gate closed status	Sluice Gate YG-12 Actuator	PI-09					DI	
68	0	G	A	U002-ZSD	Gate open status	Sluice Gate YG-12 Actuator	PI-09					DI	
69	0	X	X	U921-ET	Voltage	UV Facility 4160 Volt Bus B		Volts				TCP/IP	
70	0	X	X	U921-IT	Current	UV Facility 4160 Volt Bus B		Amps				TCP/IP	
71	0	X	X	U921-JT	Power	UV Facility 4160 Volt Bus B		kW				TCP/IP	
72	0	U	A	U930-TSH1	Winding Temperature Not at Trip Level	Transformer PDT-1						DI	
73	0	U	A	U930-TSH2	Winding Temperature Normal (Not High)	Transformer PDT-1						DI	
74	0	U	A	U930-TSH3	Oil Temperature Normal (Not High)	Transformer PDT-1						DI	

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NO.	REV. NO.	TAG NAME			DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
75	0	U	A	U930-LSL	Oil Level Normal (Not Low)	Transformer PDT-1						DI	
76	0	U	A	U930-PSH	Vacuum Pressure Normal (Not High)	Transformer PDT-1						DI	
77	0	U	A	U930-ISL	Circuit not Open	Transformer PDT-1 Grounding Resistor						DI	
78	0	U	A	U935-TSH1	Winding Temperature Not at Trip Level	Transformer UVT-2						DI	
79	0	U	A	U935-TSH2	Winding Temperature Normal (Not High)	Transformer UVT-2						DI	
80	0	U	A	U940-TSH1	Winding Temperature Not at Trip Level	Transformer UVT-3						DI	
81	0	U	A	U940-TSH2	Winding Temperature Normal (Not High)	Transformer UVT-3						DI	
82	0	U	A	U945-TSH3	Winding Temperature Not at Trip Level	Transformer LST-4						DI	
83	0	U	A	U945-TSH4	Winding Temperature Normal (Not High)	Transformer LST-4						DI	
84	0	U	A	U950-TSH3	Winding Temperature Not at Trip Level	Transformer LST-5						DI	
85	0	U	A	U950-TSH4	Winding Temperature Normal (Not High)	Transformer LST-5						DI	
86	0	U	A	U100-TT-1	Outside air temperature	HVAC	PI-11	°C				AI	
87	0	U	A	U100-TT-2	Outside air temperature	HVAC	PI-11	°C				AI	
88	0	U	A	U410-PDT	Differential air pressure	Elect Rm Air Handling Unit U-410-AHU-1	PI-11	PA				AI	
89	0	U	A	U410-TT-1	Supply air temperature	Elect Rm Air Handling Unit U-410-AHU-1	PI-12	°C				AI	
90	0	U	A	U410-TT-2	Return air temperature	Elect Rm Air Handling Unit U-410-AHU-1	PI-11	°C				AI	
91	0	U	A	U410-TT-3	Room temperature	Elect Rm Air Handling Unit U-410-AHU-1	PI-11	°C				AI	
92	0	U	A	U410-ZC-2	HC Valve Actuator Position Control	Heating coil U-410-HC	PI-22	%				AO	
93	0	U	A	U410-ZC-1	Damper position control	Econ air damper U-410-MD (U-410-AHU-1)	PI-11	%				AO	
94	0	U	A	U410-ZSB	Damper closed status	Econ air damper U-410-MD (U-410-AHU-1)	PI-11					DI	
95	0	U	A	U410-ZSD	Damper open status	Econ air damper U-410-MD (U-410-AHU-1)	PI-11					DI	
96	0	U	A	U411-MM	Motor running	Return Fan U-411-RF (U-410-AHU-1)	PI-11					DI	
97	0	U	A	U411-MN	Start Command	Return Fan U-411-RF (U-410-AHU-1)	PI-11					DO	
98	0	U	A	U411-SC	Speed control output	Return Fan U-411-RF (U-410-AHU-1)	PI-11	%				AO	
99	0	U	A	U411-UF	Fan or drive trouble	Return Fan U-411-RF (U-410-AHU-1)	PI-11					DI	
100	0	U	A	U411-YS	Computer Control Selected	Return Fan U-411-RF (U-410-AHU-1)	PI-11					DI	
101	0	U	A	U411-ZB	Damper close command	Return air damper U-411-MD (U-410-AHU-1)	PI-11					DO	
102	0	U	A	U411-ZD	Damper open command	Return air damper U-411-MD (U-410-AHU-1)	PI-11					DO	
103	0	U	A	U411-ZSB	Damper closed status	Return air damper U-411-MD (U-410-AHU-1)	PI-11					DI	
104	0	U	A	U411-ZSD	Damper open status	Return air damper U-411-MD (U-410-AHU-1)	PI-11					DI	
105	0	U	A	U412-MM	Motor running	Return Fan U-412-RF (U-410-AHU-1)	PI-11					DI	
106	0	U	A	U412-MN	Start Command	Return Fan U-412-RF (U-410-AHU-1)	PI-11					DO	
107	0	U	A	U412-SC	Speed control output	Return Fan U-412-RF (U-410-AHU-1)	PI-11	%				AO	
108	0	U	A	U412-UF	Fan or drive trouble	Return Fan U-412-RF (U-410-AHU-1)	PI-11					DI	
109	0	U	A	U412-YS	Computer Control Selected	Return Fan U-412-RF (U-410-AHU-1)	PI-11					DI	
110	0	U	A	U412-ZB	Damper close command	Return air damper U-412-MD (U-410-AHU-1)	PI-11					DO	
111	0	U	A	U412-ZD	Damper open command	Return air damper U-412-MD (U-410-AHU-1)	PI-11					DO	
112	0	U	A	U412-ZSB	Damper closed status	Return air damper U-412-MD (U-410-AHU-1)	PI-11					DI	
113	0	U	A	U412-ZSD	Damper open status	Return air damper U-412-MD (U-410-AHU-1)	PI-11					DI	
114	0	U	A	U413-ZC	Damper position control	Waste heat damper U-413-MD (U-410-AHU-1)	PI-11	%				AO	

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NO.	REV. NO.	TAG NAME			DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
115	0	U	A	U413-ZSB	Damper closed status	Waste heat damper U-413-MD (U-410-AHU-1)	PI-11					DI	
116	0	U	A	U413-ZSD	Damper open status	Waste heat damper U-413-MD (U-410-AHU-1)	PI-11					DI	
117	0	U	A	U414-ZC	Damper position control	Exhaust air damper U-414-MD (U-410-AHU-1)	PI-11	%				AO	
118	0	U	A	U414-ZSB	Damper closed status	Exhaust air damper U-414-MD (U-410-AHU-1)	PI-11					DI	
119	0	U	A	U414-ZSD	Damper open status	Exhaust air damper U-414-MD (U-410-AHU-1)	PI-11					DI	
120	0	U	A	U415-ZC	Damper position control	Outside air damper U-415-MD (U-410-AHU-1)	PI-11	%				AO	
121	0	U	A	U415-ZSB	Damper closed status	Outside air damper U-415-MD (U-410-AHU-1)	PI-11					DI	
122	0	U	A	U415-ZSD	Damper open status	Outside air damper U-415-MD (U-410-AHU-1)	PI-11					DI	
123	0	U	A	U416-MM	Motor running	Supply Fan U-416-SF (U-410-AHU-1)	PI-12					DI	
124	0	U	A	U416-MN	Start Command	Supply Fan U-416-SF (U-410-AHU-1)	PI-12					DO	
125	0	U	A	U416-SC	Speed control output	Supply Fan U-416-SF (U-410-AHU-1)	PI-12	%				AO	
126	0	U	A	U416-UF	Fan or drive trouble	Supply Fan U-416-SF (U-410-AHU-1)	PI-12					DI	
127	0	U	A	U416-YS	Computer Control Selected	Supply Fan U-416-SF (U-410-AHU-1)	PI-12					DI	
128	0	U	A	U416-ZB-1	Damper close command	Isolation damper U-416-MD-1 (U-410-AHU-1)	PI-12					DO	
129	0	U	A	U416-ZD-1	Damper open command	Isolation damper U-416-MD-1 (U-410-AHU-1)	PI-12					DO	
130	0	U	A	U416-ZSB-1	Damper closed status	Isolation damper U-416-MD-1 (U-410-AHU-1)	PI-12					DI	
131	0	U	A	U416-ZSD-1	Damper open status	Isolation damper U-416-MD-1 (U-410-AHU-1)	PI-12					DI	
132	0	U	A	U416-ZB-2	Damper close command	Air damper U-416-MD-2 (U-410-AHU-1)	PI-12					DO	
133	0	U	A	U416-ZD-2	Damper open command	Air damper U-416-MD-2 (U-410-AHU-1)	PI-12					DO	
134	0	U	A	U416-ZSB-2	Damper closed status	Air damper U-416-MD-2 (U-410-AHU-1)	PI-12					DI	
135	0	U	A	U416-ZSD-2	Damper open status	Air damper U-416-MD-2 (U-410-AHU-1)	PI-12					DI	
136	0	U	A	U416-PDSH	Filter status	U-416-SF - Filter section (U-410-AHU-1)	PI-12					DI	
137	0	U	A	U416-ZC-1	CC Valve Actuator Position Control	Cooling coil U-416-CC-1 (U-410-AHU-1)	PI-21	%				AO	
138	0	U	A	U416-ZC-2	CC Valve Actuator Position Control	Cooling coil U-416-CC-2 (U-410-AHU-1)	PI-21	%				AO	
139	0	U	A	U416-TSL	Freeze stat	Cooling coil U-416-CC (U-410-AHU-1)	PI-12					DI	
140	0	U	A	U416-TT	Mixed air temperature	Supply Fan U-416-SF (U-410-AHU-1)	PI-12					AI	
141	0	U	A	U417-MM	Motor running	Supply Fan U-417-SF (U-410-AHU-1)	PI-12					DI	
142	0	U	A	U417-MN	Start Command	Supply Fan U-417-SF (U-410-AHU-1)	PI-12					DO	
143	0	U	A	U417-SC	Speed control output	Supply Fan U-417-SF (U-410-AHU-1)	PI-12	%				AO	
144	0	U	A	U417-UF	Fan or drive trouble	Supply Fan U-417-SF (U-410-AHU-1)	PI-12					DI	
145	0	U	A	U417-YS	Computer Control Selected	Supply Fan U-417-SF (U-410-AHU-1)	PI-12					DI	
146	0	U	A	U417-ZB-1	Damper close command	Isolation damper U-417-MD-1 (U-410-AHU-1)	PI-12					DO	
147	0	U	A	U417-ZD-1	Damper open command	Isolation damper U-417-MD-1 (U-410-AHU-1)	PI-12					DO	
148	0	U	A	U417-ZSB-1	Damper closed status	Isolation damper U-417-MD-1 (U-410-AHU-1)	PI-12					DI	
149	0	U	A	U417-ZSD-1	Damper open status	Isolation damper U-417-MD-1 (U-410-AHU-1)	PI-12					DI	
150	0	U	A	U417-ZB-2	Damper close command	Air damper U-417-MD-2 (U-410-AHU-1)	PI-12					DO	
151	0	U	A	U417-ZD-2	Damper open command	Air damper U-417-MD-2 (U-410-AHU-1)	PI-12					DO	
152	0	U	A	U417-ZSB-2	Damper closed status	Air damper U-417-MD-2 (U-410-AHU-1)	PI-12					DI	
153	0	U	A	U417-ZSD-2	Damper open status	Air damper U-417-MD-2 (U-410-AHU-1)	PI-12					DI	
154	0	U	A	U417-PSH	Filter status	U-417-SF - Filter section (U-410-AHU-1)	PI-12					DI	

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NO.	REV. NO.	TAG NAME			DESCRIPTION		P&ID DRAWING	I/O SPECIFICATION					
		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
155	0	U	A	U417-ZC-1	CC Valve Actuator Position Control	Cooling coil U-417-CC-1 (U-410-AHU-1)	PI-21	%				AO	
156	0	U	A	U417-ZC-2	CC Valve Actuator Position Control	Cooling coil U-417-CC-2 (U-410-AHU-1)	PI-21	%				AO	
157	0	U	A	U417-TSL	Freeze stat	Cooling coil U-417-CC (U-410-AHU-1)	PI-12					DI	
158	0	U	A	U417-TT	Mixed air temperature	Supply Fan U-417-SF (U-410-AHU-1)	PI-12	4-20 ma				AI	
159	0	U	A	U418-ZSB-1	Damper closed status	Emergency Cooling System U-418-MD-1	PI-13					DI	
160	0	U	A	U418-ZSB-2	Damper closed status	Emergency Cooling System U-418-MD-2	PI-13					DI	
161	0	U	A	U418-ZSB-3	Damper closed status	Emergency Cooling System U-418-MD-3	PI-13					DI	
162	0	U	A	U418-TSH	Room high temperature	Emergency Cooling System	PI-13					DI	
163	0	U	A	U419-ZSB	Damper closed status	Emergency Cooling System U-419-MD	PI-13					DI	
164	0	U	A	U419-MM	Motor running	Exhaust Fan U-419-SF	PI-13					DI	
165	0	U	A	U419-YS	Auto control selected	Exhaust Fan U-419-SF	PI-13					DI	
166	0	U	A	U420-TT-1	Supply air temperature	UV Rm Air Handling Unit U-420-AHU-1	PI-14	°C				AI	
167	0	U	A	U420-TT-2	Mixed air temperature	UV Rm Air Handling Unit U-420-AHU-1	PI-14	°C				AI	
168	0	U	A	U420-TT-3	Return air temperature	UV Rm Air Handling Unit U-420-AHU-1	PI-14	°C				AI	
169	0	U	A	U420-TT-4	Room air temperature	UV Rm Air Handling Unit U-420-AHU-1	PI-14	°C				AI	
170	0	U	A	U420-AT	Room air humidity transmitter	UV Rm Air Handling Unit U-420-AHU-1	PI-14	%				AI	
171	0	U	A	U420-PDT	Differential air pressure transmitter	UV Rm Air Handling Unit U-420-AHU-1	PI-14	PA				AI	
172	0	U	A	U420-ZC-1	Damper position control	Econ air damper U-420-MD (U-420-AHU-1)	PI-14	%				AO	
173	0	U	A	U420-ZC-2	CC Valve Actuator position control	Cooling coil U-420-CC (U-420-AHU-1)	PI-21	%				AO	
174	0	U	A	U420-ZC-3	HC Valve Actuator position control	Heating coil U-420-HC (U-420-AHU-1)	PI-22	%				AO	
175	0	U	A	U420-TSL	Freeze stat	Heating coil U-420-HC (U-420-AHU-1)	PI-14					DI	
176	0	U	A	U420-PDSH	Filter status	UV Rm Air Handling Unit U-420-AHU-1	PI-14					DI	
177	0	U	A	U420-ZSB	Damper closed status	Econ air damper U-420-MD (U-420-AHU-1)	PI-14					DI	
178	0	U	A	U420-ZSD	Damper open status	Econ air damper U-420-MD (U-420-AHU-1)	PI-14					DI	
179	0	U	A	U421-MM	Motor running	Return Fan U-421-RF (U-420-AHU-1)	PI-14					DI	
180	0	U	A	U421-MN	Start command	Return Fan U-421-RF (U-420-AHU-1)	PI-14					DO	
181	0	U	A	U421-SC	Speed control output	Return Fan U-421-RF (U-420-AHU-1)	PI-14	%				AO	
182	0	U	A	U421-UF	Fan or drive trouble	Return Fan U-421-RF (U-420-AHU-1)	PI-14					DI	
183	0	U	A	U421-YS	Computer Control Selected	Return Fan U-421-RF (U-420-AHU-1)	PI-14					DI	
184	0	U	A	U422-ZC	Damper position control	Exhaust air damper U-422-MD (U-420-AHU-1)	PI-14	%				AO	
185	0	U	A	U422-ZSB	Damper closed status	Exhaust air damper U-422-MD (U-420-AHU-1)	PI-14					DI	
186	0	U	A	U422-ZSD	Damper open status	Exhaust air damper U-422-MD (U-420-AHU-1)	PI-14					DI	
187	0	U	A	U423-ZC	Damper position control	Outside air damper U-423-MD (U-420-AHU-1)	PI-14	%				AO	
188	0	U	A	U423-ZSB	Damper closed status	Outside air damper U-423-MD (U-420-AHU-1)	PI-14					DI	
189	0	U	A	U423-ZSD	Damper open status	Outside air damper U-423-MD (U-420-AHU-1)	PI-14					DI	
190	0	U	A	U424-MM	Motor running	Supply Fan U-424-SF (U-420-AHU-1)	PI-14					DI	
191	0	U	A	U424-MN	Start command	Supply Fan U-424-SF (U-420-AHU-1)	PI-14					DO	
192	0	U	A	U424-SC	Speed control output	Supply Fan U-424-SF (U-420-AHU-1)	PI-14	%				AO	
193	0	U	A	U424-UF	Fan or drive trouble	Supply Fan U-424-SF (U-420-AHU-1)	PI-14					DI	
194	0	U	A	U424-YS	Computer Control Selected	Supply Fan U-424-SF (U-420-AHU-1)	PI-14					DI	

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		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
195	0	U	A	U425-ZC	Damper position control	UV Rm Exhaust air damper U-425-MD	PI-14	%				AO	
196	0	U	A	U425-ZSB	Damper closed status	UV Rm Exhaust air damper U-425-MD	PI-14					DI	
197	0	U	A	U425-ZSD	Damper open status	UV Rm Exhaust air damper U-425-MD	PI-14					DI	
198	0	U	A	U426-MM	Motor running	UV Rm Exhaust Fan U-426-EF	PI-14					DI	
199	0	U	A	U426-MN	Start command	UV Rm Exhaust Fan U-426-EF	PI-14					DO	
200	0	U	A	U426-SC	Speed control output	UV Rm Exhaust Fan U-426-EF	PI-14	%				AO	
201	0	U	A	U426-UF	Fan or drive trouble	UV Rm Exhaust Fan U-426-EF	PI-14					DI	
202	0	U	A	U426-YS	Computer Control Selected	UV Rm Exhaust Fan U-426-EF	PI-14					DI	
203	0	U	A	U430-TT-1	Supply air temperature	Control Rm Air Handling Unit U-430-AHU-1	PI-15	°C				AI	
204	0	U	A	U430-TT-2	Mixed air temperature	Control Rm Air Handling Unit U-430-AHU-1	PI-15	°C				AI	
205	0	U	A	U430-TT-3	Room temperature	Control Rm Air Handling Unit U-430-AHU-1	PI-15	°C				AI	
206	0	U	A	U430-ZC-2	CC valve actuator position control	Cooling coil U-430-CC (U-430-AHU-1)	PI-21	%				AO	
207	0	U	A	U430-ZC-3	HC valve actuator position control	Heating coil U-430-HC (U-430-AHU-1)	PI-22	%				AO	
208	0	U	A	U430-TSL	Freeze stat	Cooling coil U-430-CC (U-430-AHU-1)	PI-15					DI	
209	0	U	A	U430-PDSH	Filter status	Control Rm Air Handling Unit U-430-AHU-1	PI-15					DI	
210	0	U	A	U430-ZC-1	Damper position control	Return air damper U-430-MD (U-430-AHU-1)	PI-15	%				AO	
211	0	U	A	U430-ZSB	Damper close status	Return air damper U-430-MD (U-430-AHU-1)	PI-15					DI	
212	0	U	A	U430-ZSD	Damper open status	Return air damper U-430-MD (U-430-AHU-1)	PI-15					DI	
213	0	U	A	U431-ZC	Damper position control	Outside air damper U-431-MD (U-430-AHU-1)	PI-15	%				AI	
214	0	U	A	U431-ZSB	Damper close status	Outside air damper U-431-MD (U-430-AHU-1)	PI-15					DI	
215	0	U	A	U431-ZSD	Damper open status	Outside air damper U-431-MD (U-430-AHU-1)	PI-15					DI	
216	0	U	A	U432-MM	Running Status	Supply Fan U-432-SF (U-430-AHU-1)	PI-15					DI	
217	0	U	A	U432-MN	Start Command	Supply Fan U-432-SF (U-430-AHU-1)	PI-15					DO	
218	0	U	A	U432-UF	Fan or motor trouble	Supply Fan U-432-SF (U-430-AHU-1)	PI-15					DI	
219	0	U	A	U432-YS	Computer Control Selected	Supply Fan U-432-SF (U-430-AHU-1)	PI-15					DI	
220	0	U	A	U433-PDSH	Filter status	Corridor Air Handling Unit U-430-AHU-2	PI-16					DI	
221	0	U	A	U434-MM	Running Status	Supply Fan U-434-SF (U-430-AHU-2)	PI-16					DI	
222	0	U	A	U434-MN	Start Command	Supply Fan U-434-SF (U-430-AHU-2)	PI-16					DO	
223	0	U	A	U434-UF	Fan or motor trouble	Supply Fan U-434-SF (U-430-AHU-2)	PI-16					DI	
224	0	U	A	U434-YS	Computer Control Selected	Supply Fan U-434-SF (U-430-AHU-2)	PI-16					DI	
225	0	U	A	U435-TT	Room air temperature	Corridor Air Handling Unit U-430-AHU-2	PI-16	°C				AI	
226	0	U	A	U451-MM	Run Status	Heat Exchanger Pump U-451-P	PI-17					DI	
227	0	U	A	U451-MN	Start Command	Heat Exchanger Pump U-451-P	PI-17					DO	
228	0	U	A	U451-YS	Computer Control Selected	Heat Exchanger Pump U-451-P	PI-17					DI	
229	0	U	A	U452-MM	Run Status	Heat Exchanger Pump U-452-P	PI-17					DI	
230	0	U	A	U452-MN	Start Command	Heat Exchanger Pump U-452-P	PI-17					DO	
231	0	U	A	U452-YS	Computer Control Selected	Heat Exchanger Pump U-452-P	PI-17					DI	
232	0	U	A	U455-TT	Effluent supply temperature	Effluent/Condenser Heat Exchanger	PI-17	°C				AI	
233	0	U	A	U456-TT	Glycol return temperature	Effluent/Condenser Heat Exchanger	PI-17	°C				AI	
234	0	U	A	U457-TT	Glycol supply temperature	Effluent/Condenser Heat Exchanger	PI-17	°C				AI	

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		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
235	0	U	A	U460-TT-1	Glycol supply temperature	Cooling Loop	PI-21	°C				AI	
236	0	U	A	U460-TT-2	Glycol return temperature	Cooling Loop	PI-21	°C				AI	
237	0	U	A	U461-MM	Run Status	Condenser loop pump U-461-P	PI-19					DI	
238	0	U	A	U461-MN	Start Command	Condenser loop pump U-461-P	PI-19					DO	
239	0	U	A	U461-YS	Computer Control Selected	Condenser loop pump U-461-P	PI-19					DI	
240	0	U	A	U462-MM	Run Status	Condenser loop pump U-462-P	PI-19					DI	
241	0	U	A	U462-MN	Start Command	Condenser loop pump U-462-P	PI-19					DO	
242	0	U	A	U462-YS	Computer Control Selected	Condenser loop pump U-462-P	PI-19					DI	
243	0	U	A	U463-MM	Run Status	Condenser loop pump U-463-P	PI-19					DI	
244	0	U	A	U463-MN	Start Command	Condenser loop pump U-463-P	PI-19					DO	
245	0	U	A	U463-YS	Computer Control Selected	Condenser loop pump U-463-P	PI-19					DI	
246	0	U	A	U464-MM	Run Status	Condenser loop pump U-464-P	PI-19					DI	
247	0	U	A	U464-MN	Start Command	Condenser loop pump U-464-P	PI-19					DO	
248	0	U	A	U464-YS	Computer Control Selected	Condenser loop pump U-464-P	PI-19					DI	
249	0	U	A	U465-MM	Run Status	Condenser loop pump U-465-P	PI-18					DI	
250	0	U	A	U465-MN	Start Command	Condenser loop pump U-465-P	PI-18					DO	
251	0	U	A	U465-YS	Computer Control Selected	Condenser loop pump U-465-P	PI-18					DI	
252	0	U	A	U466-MM	Run Status	Condenser loop pump U-466-P	PI-18					DI	
253	0	U	A	U466-MN	Start Command	Condenser loop pump U-466-P	PI-18					DO	
254	0	U	A	U466-YS	Computer Control Selected	Condenser loop pump U-466-P	PI-18					DI	
255	0	U	A	U467-MM	Run Status	Condenser loop pump U-467-P	PI-18					DI	
256	0	U	A	U467-MN	Start Command	Condenser loop pump U-467-P	PI-18					DO	
257	0	U	A	U467-YS	Computer Control Selected	Condenser loop pump U-467-P	PI-18					DI	
258	0	U	A	U468-MM	Run Status	Condenser loop pump U-468-P	PI-18					DI	
259	0	U	A	U468-MN	Start Command	Condenser loop pump U-468-P	PI-18					DO	
260	0	U	A	U468-YS	Computer Control Selected	Condenser loop pump U-468-P	PI-18					DI	
261	0	U	A	U469-MM	Run Status	Heat pump U-469-HP	PI-19					DI	
262	0	U	A	U469-MN	Start Command	Heat pump U-469-HP	PI-19					DO	
263	0	U	A	U469-MF	Motor trouble	Heat pump U-469-HP	PI-19					DI	
264	0	U	A	U469-YS	Computer Control Selected	Heat pump U-469-HP	PI-19					DI	
265	0	U	A	U470-MM	Run Status	Heat pump U-470-HP	PI-19					DI	
266	0	U	A	U470-MN	Start Command	Heat pump U-470-HP	PI-19					DO	
267	0	U	A	U470-MF	Motor trouble	Heat pump U-470-HP	PI-19					DI	
268	0	U	A	U470-YS	Computer Control Selected	Heat pump U-470-HP	PI-19					DI	
269	0	U	A	U471-MM	Run Status	Heat pump U-471-HP	PI-18					DI	
270	0	U	A	U471-MN	Start Command	Heat pump U-471-HP	PI-18					DO	
271	0	U	A	U471-MF	Motor trouble	Heat pump U-471-HP	PI-18					DI	
272	0	U	A	U471-YS	Computer Control Selected	Heat pump U-471-HP	PI-18					DI	
273	0	U	A	U472-MM	Run Status	Heat pump U-472-HP	PI-18					DI	
274	0	U	A	U472-MN	Start Command	Heat pump U-472-HP	PI-18					DO	

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		PCU		DEVICE	FUNCTION	SERVICE		ENG. UNITS	SCALE LOW-HIGH	ALARMS		I/O POINT TYPE	I/O POINT NO.
		AREA	PNL	TAG						LOW	HIGH		
275	0	U	A	U472-MF	Motor trouble	Heat pump U-472-HP	PI-18					DI	
276	0	U	A	U472-YS	Computer Control Selected	Heat pump U-472-HP	PI-18					DI	
277	0	U	A	U473-MM	Run Status	Heat pump U-473-HP	PI-18					DI	
278	0	U	A	U473-MN	Start Command	Heat pump U-473-HP	PI-18					DO	
279	0	U	A	U473-MF	Motor trouble	Heat pump U-473-HP	PI-18					DI	
280	0	U	A	U473-YS	Computer Control Selected	Heat pump U-473-HP	PI-18					DI	
281	0	U	A	U474-LSL	Low Level	Glycol fill pump U-474-GFT	PI-17					DI	
282	0	U	A	U480-TT-1	Glycol supply temperature	Heating Loop	PI-22	°C				AI	
283	0	U	A	U480-TT-2	Glycol return temperature	Heating Loop	PI-22	°C				AI	
284	0	U	A	U481-MM	Run Status	Condenser loop pump U-481-P	PI-20					DI	
285	0	U	A	U481-MN	Start Command	Condenser loop pump U-481-P	PI-20					DO	
286	0	U	A	U481-YS	Computer Control Selected	Condenser loop pump U-481-P	PI-20					DI	
287	0	U	A	U482-MM	Run Status	Heating loop pump U-482-P	PI-20					DI	
288	0	U	A	U482-MN	Start Command	Heating loop pump U-482-P	PI-20					DO	
289	0	U	A	U482-YS	Computer Control Selected	Heating loop pump U-482-P	PI-20					DI	
290	0	U	A	U483-MM	Run Status	Condenser loop pump U-483-P	PI-20					DI	
291	0	U	A	U483-MN	Start Command	Condenser loop pump U-483-P	PI-20					DO	
292	0	U	A	U483-YS	Computer Control Selected	Condenser loop pump U-483-P	PI-20					DI	
293	0	U	A	U484-MM	Run Status	Heating loop pump U-484-P	PI-20					DI	
294	0	U	A	U484-MN	Start Command	Heating loop pump U-484-P	PI-20					DO	
295	0	U	A	U484-YS	Computer Control Selected	Heating loop pump U-484-P	PI-20					DI	
296	0	U	A	U485-MM	Run Status	Heating loop pump U-485-P	PI-20					DI	
297	0	U	A	U485-MN	Start Command	Heating loop pump U-485-P	PI-20					DO	
298	0	U	A	U485-YS	Computer Control Selected	Heating loop pump U-485-P	PI-20					DI	
299	0	U	A	U486-MM	Run Status	Heat pump U-486-HP	PI-20					DI	
300	0	U	A	U486-MN	Start Command	Heat pump U-486-HP	PI-20					DO	
301	0	U	A	U486-MF	Motor trouble	Heat pump U-486-HP	PI-20					DI	
302	0	U	A	U486-YS	Computer Control Selected	Heat pump U-486-HP	PI-20					DI	
303	0	U	A	U487-MM	Run Status	Heat pump U-487-HP	PI-20					DI	
304	0	U	A	U487-MN	Start Command	Heat pump U-487-HP	PI-20					DO	
305	0	U	A	U487-MF	Motor trouble	Heat pump U-487-HP	PI-20					DI	
306	0	U	A	U487-YS	Computer Control Selected	Heat pump U-487-HP	PI-20					DI	
307	0	U	A	U488-MM	Run Status	Heat pump U-488-HP	PI-20					DI	
308	0	U	A	U488-MN	Start Command	Heat pump U-488-HP	PI-20					DO	
309	0	U	A	U488-MF	Motor trouble	Heat pump U-488-HP	PI-20					DI	
310	0	U	A	U488-YS	Computer Control Selected	Heat pump U-488-HP	PI-20					DI	
311	0	U	A	U489-MM	On Status	Electric boiler U-489-EB	PI-20					DI	
312	0	U	A	U489-MN	On Command	Electric boiler U-489-EB	PI-20					DO	
313	0	U	A	U489-UF	Trouble	Electric boiler U-489-EB	PI-20					DI	

I/O POINT TYPES: AI = Analog Input, AO = Analog Output, DI = Discrete Input, DO = Discrete Output, MB = Modbus, TCP/IP = Ethernet

INSTRUMENT INDEX

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Index

.1 The following spreadsheet gives an itemized list of the instrumentation included as part of this Work.

2. PRODUCTS

.1 Not used in this Section.

3. EXECUTION

.1 Not used in this Section.

END OF SECTION

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Project No. 66303

RECORD NO.	REV. NO.	TAG NAME	DESCRIPTION		REFERENCES				
			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
1	0	U002-HS-1	COH Selector Switch	Sluice Gate YG-12 Actuator	17216	PI-04			CON
2	0	U002-HS-2	Close Pushbutton	Sluice Gate YG-12 Actuator	17216	PI-04			CON
3	0	U002-HS-3	Open Pushbutton	Sluice Gate YG-12 Actuator	17216	PI-04			CON
4	0	U002-ZSB	Closed Limit Switch	Sluice Gate YG-12 Actuator		PI-04			CON
5	0	U002-ZSD	Open Limit Switch	Sluice Gate YG-12 Actuator		PI-04			CON
6	0	U005-LE	Ultrasonic Liquid Level Transducer	UV Influent Pump Well		PI-04		I2-01	CON
7	0	U005-LIT	Ultrasonic Liquid Level Transmitter	UV Influent Pump Well		PI-04		I2-01	CON
8	0	U010-AE	Pump Motor Moisture/Temperature Element	UV Influent Pump U-010-P-1		PI-06		I2-02	CITY
9	0	U010-AY	Pump Motor Moisture/Temperature Switch	UV Influent Pump U-010-P-1		PI-06		I2-01	CITY
10	0	U010-HS-1	Lock-off-stop Pushbutton	UV Influent Pump U-010-P-1	17216	PI-06		I2-01	CITY
11	0	U010-HS-2	COH Selector Switch	UV Influent Pump U-010-P-1 VFD	17216	PI-06		I2-01	CITY
12	0	U010-NLF	Pump Motor Moisture Alarm Pilot Light	UV Influent Pump U-010-P-1	17216	PI-06		I2-01	CITY
13	0	U010-TLF	Pump Motor Temperature Alarm Pilot Light	UV Influent Pump U-010-P-1	17216	PI-06		I2-01	CITY
14	0	U020-AE	Pump Motor Moisture/Temperature Element	UV Influent Pump U-020-P-1		PI-06		I2-02	CITY
15	0	U020-AY	Pump Motor Moisture/Temperature Switch	UV Influent Pump U-020-P-1		PI-06		I2-01	CITY
16	0	U020-HS-1	Lock-off-stop Pushbutton	UV Influent Pump U-020-P-1	17216	PI-06		I2-01	CITY
17	0	U020-HS-2	COH Selector Switch	UV Influent Pump U-020-P-1 VFD	17216	PI-06		I2-01	CITY
18	0	U020-NLF	Pump Motor Moisture Alarm Pilot Light	UV Influent Pump U-020-P-1	17216	PI-06		I2-01	CITY
19	0	U020-TLF	Pump Motor Temperature Alarm Pilot Light	UV Influent Pump U-020-P-1	17216	PI-06		I2-01	CITY
20	0	U030-AE	Pump Motor Moisture/Temperature Element	UV Influent Pump U-030-P-1		PI-06		I2-02	CITY
21	0	U030-AY	Pump Motor Moisture/Temperature Switch	UV Influent Pump U-030-P-1		PI-06		I2-01	CITY
22	0	U030-HS-1	Lock-off-stop Pushbutton	UV Influent Pump U-030-P-1	17216	PI-06		I2-01	CITY
23	0	U030-HS-2	COH Selector Switch	UV Influent Pump U-030-P-1 VFD	17216	PI-06		I2-01	CITY
24	0	U030-NLF	Pump Motor Moisture Alarm Pilot Light	UV Influent Pump U-030-P-1	17216	PI-06		I2-01	CITY
25	0	U030-TLF	Pump Motor Temperature Alarm Pilot Light	UV Influent Pump U-030-P-1	17216	PI-06		I2-01	CITY
26	0	U040-AE	Pump Motor Moisture/Temperature Element	UV Influent Pump U-040-P-1		PI-06		I2-02	CITY
27	0	U040-AY	Pump Motor Moisture/Temperature Switch	UV Influent Pump U-040-P-1		PI-06		I2-01	CITY
28	0	U040-HS-1	Lock-off-stop Pushbutton	UV Influent Pump U-040-P-1	17216	PI-06		I2-01	CITY
29	0	U040-HS-2	COH Selector Switch	UV Influent Pump U-040-P-1 VFD	17216	PI-06		I2-01	CITY
30	0	U040-NLF	Pump Motor Moisture Alarm Pilot Light	UV Influent Pump U-040-P-1	17216	PI-06		I2-01	CITY
31	0	U040-TLF	Pump Motor Temperature Alarm Pilot Light	UV Influent Pump U-040-P-1	17216	PI-06		I2-01	CITY
32	0	U050-AE	Pump Motor Moisture/Temperature Element	UV Influent Pump U-050-P-1		PI-06		I2-02	CITY
33	0	U050-AY	Pump Motor Moisture/Temperature Switch	UV Influent Pump U-050-P-1		PI-06		I2-01	CITY

SUPPLY CODES: CON = Contractor Supply, CITY = City Suppy, PKG = Part of Equipment Package, Trojan = UV Vendor Supply

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			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
34	0	U050-HS-1	Lock-off-stop Pushbutton	UV Influent Pump U-050-P-1	17216	PI-06		I2-01	CITY
35	0	U050-HS-2	COH Selector Switch	UV Influent Pump U-050-P-1 VFD	17216	PI-06		I2-01	CITY
36	0	U050-NLF	Pump Motor Moisture Alarm Pilot Light	UV Influent Pump U-050-P-1	17216	PI-06		I2-01	CITY
37	0	U050-TLF	Pump Motor Temperature Alarm Pilot Light	UV Influent Pump U-050-P-1	17216	PI-06		I2-01	CITY
38	0	U060-FE	Ultrasonic Open Channel Flow Transducer	UV Influent Pump Discharge Channel Level		PI-07			CON
39	0	U060-FIT	Ultrasonic Open Channel Flowl Transmitter	UV Influent Pump Discharge Channel Level		PI-07			CON
40	0	U102-HS-1	Local/Remote Selector Switch	Weir Gate U-100-SG-1	17216	PI-10		I2-01	CON
41	0	U102-HS-2	Open Pushbutton	Weir Gate U-100-SG-1	17216	PI-10		I2-01	CON
42	0	U102-HS-3	Close Pushbutton	Weir Gate U-100-SG-1	17216	PI-10		I2-01	CON
43	0	U102-ZSB	Closed Limit Switch	Weir Gate U-100-SG-1		PI-10		I2-01	CON
44	0	U102-ZSD	Open Limit Switch	Weir Gate U-100-SG-1		PI-10		I2-01	CON
45	0	U102-ZT	Position Transmitter	Weir Gate U-100-SG-1		PI-10		I2-01	CON
46	0	U111-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 1A		PI-07		I2-02	Trojan
47	0	U121-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 1B		PI-07		I2-02	Trojan
48	0	U170-LE	Ultrasonic Liquid Level Transducer	UV Reactor Channel #1		PI-07		I2-02	Trojan
49	0	U170-LIT	Ultrasonic Liquid Level Transmitter	UV Reactor Channel #1		PI-07		I2-02	Trojan
50	0	U202-HS-1	COH Selector Switch	Weir Gate U-200-SG-1	17216	PI-10		I2-01	CON
51	0	U202-HS-2	Open Pushbutton	Weir Gate U-200-SG-1	17216	PI-10		I2-01	CON
52	0	U202-HS-3	Close Pushbutton	Weir Gate U-200-SG-1	17216	PI-10		I2-01	CON
53	0	U202-ZSB	Closed Limit Switch	Weir Gate U-200-SG-1		PI-10		I2-01	CON
54	0	U202-ZSD	Open Limit Switch	Weir Gate U-200-SG-1		PI-10		I2-01	CON
55	0	U202-ZT	Position Transmitter	Weir Gate U-200-SG-1		PI-10		I2-01	CON
56	0	U211-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 2A		PI-08		I2-02	Trojan
57	0	U221-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 2B		PI-08		I2-02	Trojan
58	0	U270-LE	Ultrasonic Liquid Level Transducer	UV Reactor Channel #2		PI-08		I2-02	Trojan
59	0	U270-LIT	Ultrasonic Liquid Level Transmitter	UV Reactor Channel #2		PI-08		I2-02	Trojan
60	0	U302-HS-1	COH Selector Switch	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
61	0	U302-HS-2	Open Pushbutton	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
62	0	U302-HS-3	Close Pushbutton	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
63	0	U302-ZSB	Closed Limit Switch	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
64	0	U302-ZSD	Open Limit Switch	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
65	0	U302-ZT	Position Transmitter	Weir Gate U-300-SG-1	17216	PI-10		I2-01	CON
66	0	U311-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 3A		PI-09		I2-02	Trojan

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			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
67	0	U321-AT	UV Light Intensity Sensor/Transmitter	UV Reactor Bank 3B		PI-09		I2-02	Trojan
68	0	U370-LE	Ultrasonic Liquid Level Transducer	UV Reactor Channel #3		PI-09		I2-02	Trojan
69	0	U370-LIT	Ultrasonic Liquid Level Transmitter	UV Reactor Channel #3		PI-09		I2-02	Trojan
70	0	U910-ZS-1	Infra-Red Motion Sensor	UV Facility Process Room				E1-06	CON
71	0	U910-ZS-2	Infra-Red Motion Sensor	UV Facility Process Room				E1-06	CON
72	0	U910-ZS-3	Infra-Red Motion Sensor	UV Facility Process Room				E1-06	CON
73	0	U910-ZS-4	Infra-Red Motion Sensor	UV Facility Process Room				E1-06	CON
74	0	U911-ZS	Infra-Red Motion Sensor	UV Facility Entrance Hall				E1-06	CON
75	0	U912-ZS-1	Infra-Red Motion Sensor	UV Facility Electrical Room				E1-06	CON
76	0	U912-ZS-2	Infra-Red Motion Sensor	UV Facility Electrical Room				E1-06	CON
77	0	U913-ZS	Door Switch	UV Facility Entrance				E1-06	CON
78	0	U914-ZS	Door Switch	UV Facility Process Room				E1-06	CON
79	0	U100-TT-1	Outside Air Temperature Transmitter	HVAC		PI-11		M4-01	CON
80	0	U100-TT-2	Outside Air Temperature Transmitter	HCAV		PI-11		M4-01	CON
81	0	U410-TT-1	Supply Air Duct Temperature Transmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
82	0	U410-TT-2	Return Air Duct Temperature Transmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-11		M5-01	CON
83	0	U410-TT-3	Room Air Temperature Transmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-11		M4-01	CON
84	0	U410-PDT	Differential Pressure Transmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-11		M5-01	CON
85	0	U410-ZSB	Closed Limit Switch	Econ air damper U-410-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
86	0	U410-ZSD	Open Limit Switch	Econ air damper U-410-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
87	0	U411-HS	COH Selector Switch	Return Fan U-411-RF (U-410-AHU-1)	17216	PI-11		M5-01	CON
88	0	U411-ZSB	Closed Limit Switch	Return air damper U-411-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
89	0	U411-ZSD	Open Limit Switch	Return air damper U-411-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
90	0	U412-HS	COH Selector Switch	Return Fan U-412-RF (U-410-AHU-1)	17216	PI-11		M5-01	CON
91	0	U412-ZSB	Closed Limit Switch	Return air damper U-412-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
92	0	U412-ZSD	Open Limit Switch	Return air damper U-412-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
93	0	U413-ZSB	Closed Limit Switch	Waste heat damper U-413-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
94	0	U413-ZSD	Open Limit Switch	Waste heat damper U-413-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
95	0	U414-ZSB	Closed Limit Switch	Exhaust air damper U-414-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
96	0	U414-ZSD	Open Limit Switch	Exhaust air damper U-414-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
97	0	U415-ZSB	Closed Limit Switch	Outside air damper U-415-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
98	0	U415-ZSD	Open Limit Switch	Outside air damper U-415-MD (U-410-AHU-1)	15835	PI-11		M5-01	CON
99	0	U416-TT	Mixed Air Duct Temperature Trasmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON

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			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
100	0	U416-TSL	Freeze Stat	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
101	0	U416-PSH	Filter status	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
102	0	U416-HS	COH Selector Switch	Supply Fan U-416-SF (U-410-AHU-1)	17216	PI-12		M5-01	CON
103	0	U416-ZSB-1	Closed Limit Switch	Isolation damper U-416-MD-1 (U-410-AHU-1)	15835	PI-12		M5-01	CON
104	0	U416-ZSD-1	Open Limit Switch	Isolation damper U-416-MD-1 (U-410-AHU-1)	15835	PI-12		M5-01	CON
105	0	U416-ZSB-2	Closed Limit Switch	Air damper U-416-MD-2 (U-410-AHU-1)	15835	PI-12		M5-01	CON
106	0	U416-ZSD-2	Open Limit Switch	Air damper U-416-MD-2 (U-410-AHU-1)	15835	PI-12		M5-01	CON
107	0	U417-TT	Mixed Air Duct Temperature Trasmitter	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
108	0	U417-TSL	Freeze Stat	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
109	0	U417-PSH	Filter status	Elect Rm Air Handling Unit U-410-AHU-1		PI-12		M5-01	CON
110	0	U417-HS	COH Selector Switch	Supply Fan U-416-SF (U-410-AHU-1)	17216	PI-12		M5-01	CON
111	0	U417-ZSB-1	Closed Limit Switch	Isolation damper U-417-MD-1 (U-410-AHU-1)	15835	PI-12		M5-01	CON
112	0	U417-ZSD-1	Open Limit Switch	Isolation damper U-417-MD-1 (U-410-AHU-1)	15835	PI-12		M5-01	CON
113	0	U417-ZSB-2	Closed Limit Switch	Air damper U-417-MD-2 (U-410-AHU-1)	15835	PI-12		M5-01	CON
114	0	U417-ZSD-2	Open Limit Switch	Air damper U-417-MD-2 (U-410-AHU-1)	15835	PI-12		M5-01	CON
115	0	U418-ZSB-1	Closed Limit Switch	Emergency Cooling System U-418-MD-1	15835	PI-13		M6-01	CON
116	0	U418-ZSD-1	Open Limit Switch	Emergency Cooling System U-418-MD-1	15835	PI-13		M6-01	CON
117	0	U418-ZSB-2	Closed Limit Switch	Emergency Cooling System U-418-MD-2	15835	PI-13		M6-01	CON
118	0	U418-ZSD-2	Open Limit Switch	Emergency Cooling System U-418-MD-2	15835	PI-13		M6-01	CON
119	0	U418-ZSB-2	Closed Limit Switch	Emergency Cooling System U-418-MD-3	15835	PI-13		M6-01	CON
120	0	U418-ZSD-2	Open Limit Switch	Emergency Cooling System U-418-MD-3	15835	PI-13		M6-01	CON
121	0	U418-TSH	Room Air Temperature Cooling Termostat	Exhaust Fan U-419-SF		PI-13		M6-01	CON
122	0	U419-HS	COH Selector Switch	Exhaust Fan U-419-SF	17216	PI-13		M6-01	CON
123	0	U419-MM	Running Pilot Light	Exhaust Fan U-419-SF	17216	PI-13		M6-01	CON
124	0	U419-ZSB	Closed Limit Switch	Isolation damper U-417-MD-1 (U-410-AHU-1)	15835	PI-13		M6-01	CON
125	0	U419-ZSD	Open Limit Switch	Isolation damper U-417-MD-1 (U-410-AHU-1)	15835	PI-13		M6-01	CON
126	0	U420-TT-1	Supply Air Duct Temperature Transmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
127	0	U420-TT-2	Mixed Air Duct Temperature Trasmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
128	0	U420-TT-3	Supply Air Temperature Transmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
129	0	U420-TT-4	Room Air Temperature Transmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
130	0	U420-AT	Room air humidity transmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
131	0	U420-PDT	Differential air pressure transmitter	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
132	0	U420-PDSH	Filter status	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON

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133	0	U420-TSL	Freeze Stat	UV Rm Air Handling Unit U-420-AHU-1		PI-14		M4-01	CON
134	0	U420-ZSB	Closed Limit Switch	Econ air damper U-420-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
135	0	U420-ZSD	Open Limit Switch	Econ air damper U-420-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
136	0	U421-HS	COH Selector Switch	Return Fan U-421-RF (U-420-AHU-1)	17216	PI-14		M4-01	CON
137	0	U422-ZSB	Closed Limit Switch	Exhaust air damper U-422-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
138	0	U422-ZSD	Open Limit Switch	Exhaust air damper U-422-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
139	0	U423-ZSB	Closed Limit Switch	Outside air damper U-423-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
140	0	U423-ZSD	Open Limit Switch	Outside air damper U-423-MD (U-420-AHU-1)	15835	PI-14		M4-01	CON
141	0	U424-HS	COH Selector Switch	Supply Fan U-424-SF (U-420-AHU-1)	17216	PI-14		M4-01	CON
142	0	U425-ZSB	Closed Limit Switch	UV Rm Exhaust air damper U-425-MD	15835	PI-14		M4-01	CON
143	0	U425-ZSD	Open Limit Switch	UV Rm Exhaust air damper U-425-MD	15835	PI-14		M4-01	CON
144	0	U426-HS	COH Selector Switch	UV Rm Exhaust Fan U-426-EF	17216	PI-14		M6-01	CON
145	0	U430-TT-1	Supply Air Duct Temperature Transmitter	Control Rm Air Handling Unit U-430-AHU-1		PI-15		M4-01	CON
146	0	U430-TT-2	Mixed Air Duct Temperature Trasmitter	Control Rm Air Handling Unit U-430-AHU-1		PI-15		M4-01	CON
147	0	U430-TT-3	Room Air Temperature Transmitter	Control Rm Air Handling Unit U-430-AHU-1		PI-15		M4-01	CON
148	0	U430-PSH	Filter status	Control Rm Air Handling Unit U-430-AHU-1		PI-15		M4-01	CON
149	0	U430-TSL	Freeze Stat	Control Rm Air Handling Unit U-430-AHU-1		PI-15		M4-01	CON
150	0	U430-ZSB	Closed Limit Switch	Return air damper U-430-MD (U-430-AHU-1)	15835	PI-15		M4-01	CON
151	0	U430-ZSD	Open Limit Switch	Return air damper U-430-MD (U-430-AHU-1)	15835	PI-15		M4-01	CON
152	0	U431-ZSB	Closed Limit Switch	Outside air damper U-431-MD (U-430-AHU-1)	15835	PI-15		M4-01	CON
153	0	U431-ZSD	Open Limit Switch	Outside air damper U-431-MD (U-430-AHU-1)	15835	PI-15		M4-01	CON
154	0	U432-HS	COH Selector Switch	Supply Fan U-432-SF (U-430-AHU-1)	17216	PI-15		M4-01	CON
155	0	U432-IS	Current Switch	Supply Fan U-432-SF (U-430-AHU-1)		PI-15		M4-01	CON
156	0	U432-MM	Running Pilot Light	Supply Fan U-432-SF (U-430-AHU-1)	17216	PI-15		M4-01	CON
157	0	U433-PSH	Filter status	Corridor Air Handling Unit U-430-AHU-2		PI-16		M4-01	CON
158	0	U434-HS	COH Selector Switch	Supply Fan U-434-SF (U-430-AHU-2)	17216	PI-16		M4-01	CON
159	0	U434-IS	Current Switch	Supply Fan U-434-SF (U-430-AHU-2)		PI-16		M4-01	CON
160	0	U434-MM	Running Pilot Light	Supply Fan U-434-SF (U-430-AHU-2)	17216	PI-16		M4-01	CON
161	0	U435-TT	Room Air Temperature Transmitter	Corridor Air Handling Unit U-430-AHU-2		PI-16		M4-01	CON
162	0	U440-HS	Start/Stop Switch	Exhaust Fan U-440-EF		PI-16		M4-01	CON
163	0	U445-HS	Room Air Temperature Cooling Termostat	Exhaust Fan U-445-EF		PI-16		M1-02	CON
164	0	U455-TT	Effluent Supply Temperature Transmitter	Effluent/Condenser Heat Exchanger		PI-17		M6-02	CON
165	0	U456-TT	Glycol Return Temperature Transmitter	Effluent/Condenser Heat Exchanger		PI-17		M6-02	CON

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RECORD NO.	REV. NO.	TAG NAME	DESCRIPTION		REFERENCES				
			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
166	0	U457-TT	Gycol Supply Temperature Transmitter	Effluent/Condenser Heat Exchanger		PI-17		M6-02	CON
167	0	U451-HS	COH Selector Switch	Heat Exchanger Pump U-451-P	17216	PI-17		MCC	CON
168	0	U451-MM	Pump Running Pilot Light	Heat Exchanger Pump U-451-P	17216	PI-17		MCC	CON
169	0	U452-HS	COH Selector Switch	Heat Exchanger Pump U-452-P	17216	PI-17		MCC	CON
170	0	U452-MM	Pump Running Pilot Light	Heat Exchanger Pump U-452-P	17216	PI-17		MCC	CON
171	0	U474-PS	Pressure Switch (Low)	Glycol Pressurization Unit U-474		PI-17		M3-01	CON
172	0	U474-LSL	Low Level Switch	Glycol Pressurization Unit U-474		PI-17		M3-01	CON
173	0	U460-TT-1	Gycol supply temperature	Cooling Loop		PI-21		M3-01	CON
174	0	U460-TT-2	Glycol return temperature	Cooling Loop		PI-21		M3-01	CON
175	0	U461-HS	COH Selector Switch	Condenser loop pump U-461-P	17216	PI-19		MCC	CON
176	0	U461-MM	Pump Running Pilot Light	Condenser loop pump U-461-P	17216	PI-19		MCC	CON
177	0	U462-HS	COH Selector Switch	Condenser loop pump U-462-P	17216	PI-19		MCC	CON
178	0	U462-MM	Pump Running Pilot Light	Condenser loop pump U-462-P	17216	PI-19		MCC	CON
179	0	U463-HS	COH Selector Switch	Condenser loop pump U-463-P	17216	PI-19		MCC	CON
180	0	U463-MM	Pump Running Pilot Light	Condenser loop pump U-463-P	17216	PI-19		MCC	CON
181	0	U464-HS	COH Selector Switch	Condenser loop pump U-464-P	17216	PI-19		MCC	CON
182	0	U464-MM	Pump Running Pilot Light	Condenser loop pump U-464-P	17216	PI-19		MCC	CON
183	0	U465-HS	COH Selector Switch	Condenser loop pump U-465-P	17216	PI-18		MCC	CON
184	0	U465-MM	Pump Running Pilot Light	Condenser loop pump U-465-P	17216	PI-18		MCC	CON
185	0	U466-HS	COH Selector Switch	Condenser loop pump U-466-P	17216	PI-18		MCC	CON
186	0	U466-MM	Pump Running Pilot Light	Condenser loop pump U-466-P	17216	PI-18		MCC	CON
187	0	U467-HS	COH Selector Switch	Condenser loop pump U-467-P	17216	PI-18		MCC	CON
188	0	U467-MM	Pump Running Pilot Light	Condenser loop pump U-467-P	17216	PI-18		MCC	CON
189	0	U468-HS	COH Selector Switch	Condenser loop pump U-468-P	17216	PI-18		MCC	CON
190	0	U468-MM	Pump Running Pilot Light	Condenser loop pump U-468-P	17216	PI-18		MCC	CON
191	0	U469-HS	COH Selector Switch	Heat pump U-469-HP	17216	PI-19		M3-01	CON
192	0	U470-HS	COH Selector Switch	Heat pump U-470-HP	17216	PI-19		M3-01	CON
193	0	U471-HS	COH Selector Switch	Heat pump U-471-HP	17216	PI-18		M3-01	CON
194	0	U472-HS	COH Selector Switch	Heat pump U-472-HP	17216	PI-18		M3-01	CON
195	0	U473-HS	COH Selector Switch	Heat pump U-473-HP	17216	PI-18		M3-01	CON
196	0	U480-TT-1	Gycol supply temperature	Heating Loop		PI-21		M3-01	CON
197	0	U480-TT-2	Glycol return temperature	Heating Loop		PI-21		M3-01	CON
198	0	U481-HS	COH Selector Switch	Condenser loop pump U-481-P	17216	PI-20		MCC	CON

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Project No. 66303

RECORD NO.	REV. NO.	TAG NAME	DESCRIPTION		REFERENCES				
			INSTRUMENT TYPE	SERVICE	SPEC. SHEET or SECTION	P&ID DRAWING	WIRING REF.	LOATION DWG-	SUPPLY CODE
199	0	U481-MM	Pump Running Pilot Light	Condenser loop pump U-481-P	17216	PI-20		MCC	CON
200	0	U482-HS	COH Selector Switch	Condenser loop pump U-482-P	17216	PI-20		MCC	CON
201	0	U482-MM	Pump Running Pilot Light	Condenser loop pump U-482-P	17216	PI-20		MCC	CON
202	0	U483-HS	COH Selector Switch	Condenser loop pump U-483-P	17216	PI-20		MCC	CON
203	0	U483-MM	Pump Running Pilot Light	Condenser loop pump U-483-P	17216	PI-20		MCC	CON
204	0	U484-HS	COH Selector Switch	Condenser loop pump U-484-P	17216	PI-20		MCC	CON
205	0	U484-MM	Pump Running Pilot Light	Condenser loop pump U-484-P	17216	PI-20		MCC	CON
206	0	U485-HS	COH Selector Switch	Condenser loop pump U-485-P	17216	PI-20		MCC	CON
207	0	U485-MM	Pump Running Pilot Light	Condenser loop pump U-485-P	17216	PI-20		MCC	CON
208	0	U486-HS	COH Selector Switch	Heat pump U-486-HP	17216	PI-20		M3-01	CON
209	0	U487-HS	COH Selector Switch	Heat pump U-487-HP	17216	PI-20		M3-01	CON
210	0	U488-HS	COH Selector Switch	Heat pump U-488-HP	17216	PI-20		M3-01	CON
211	0	U489-HS	COH Selector Switch	Electric boiler U-489-EB	17216	PI-20		M5-01	CON

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INSTRUMENT SPECIFICATION SHEETS

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Specification Sheets

.1 The following data sheets provide information for instruments included as part of this Work.

.2 All instruments described in the instrument Specification sheets are to be from a single source. Design has been based on the first named Supplier. Acceptable single source Suppliers are Moore Products, Bailey, Fisher-Rosemount and E&H.

2. PRODUCTS

.1 Not used in this Section.

3. EXECUTION

.1 Not used in this Section.

END OF SECTION

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:		I101
DEVICE:		Liquid Level Transmitter
TAG:		LE/LIT-U005
TYPE:		Ultrasonic
SERVICE:		Level measurement of effluent wastewater upstream of the outfall chamber by-pass weir
RANGE:		To be confirmed during construction
INACCURACY:		±0.5% of span
OUTPUT:		4 to 20 mA DC into 500 OHM load 5 configurable alarm relays
POWER SUPPLY:		120 VAC, 60 HZ
ENCLOSURE:		NEMA 4X Transmitter Housing NEMA 4X Sensor
MOUNTING:	**(TRANSMITTER)** **(SENSOR)**	Wall Mount Mount sensor on PVC pipe stilling well where shown on the drawings, provide PVC blind flange for mounting sensor.
ACCESSORIES:		1 - hand-held programmer
MANUFACTURER AND MODEL:		Milltronics Hydroranger Plus or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I102
DEVICE:	Motion Detector
TAG:	ZS-U910-1 ZS-U910-2 ZS-U910-3 ZS-U910-4 ZS-U911-1 ZS-U912-1 ZS-U912-2
TYPE:	Combination Infra-red and microwave
CALIBRATION:	User adjustable detection patterns
OUTPUT:	Form C Reed Relay rated 500 mA @ 300 VDC
POWER SUPPLY:	9 to 30 VDC
MOUNTING:	Surface Mount
MANUFACTURER AND MODEL:	C&K Systems DT-450C or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I103
DEVICE:	Door Switch
TAG:	ZS-U913 ZS-U914
TYPE:	Electronic
SERVICE:	Equipment Room and Electrical Room
DISPLAY:	LED Status Indicator
OUTPUT:	SPDT Contact
POWER SUPPLY:	120 VAC, 60 HZ
ENCLOSURE:	Surface Mount

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I104
DEVICE:	Humidity & Temperature Transmitter
TAG:	U410-TT-3, U420-TT-4, U420-AT, U410-AT, U430-TT-3, U435-TT, U430-AT, U435-AT
SERVICE:	Ambient Air Temperature Transmitter with built-in Humidity Transmitter.
RANGE:	0°C to 50°C
DISPLAY:	Three digit LED display with one decimal point.
OUTPUT:	4 to 20 mA DC Humidity 4 to 20 mA DC Temperature
ENCLOSURE:	NEMA 4, 4x.
MOUNTING:	Wall
MANUFACTURER AND MODEL:	EE10 Series model EE10 FT6D04 or approved equal.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:		I105
DEVICE:		Open Channel Flow Meter
TAG:		FE/FIT-U060
TYPE:		Ultrasonic
SERVICE:		U.V. influent flow measurement
RANGE:		To be confirmed during construction. Program the unit using Weir formula to be provided by the consultant.
INACCURACY:		± 1 mm/m of span
OUTPUT:		4 to 20 mA DC into 500 OHM load 5 configurable alarm relays
POWER SUPPLY:		120 VAC, 60 HZ
ENCLOSURE:		NEMA 4X Transmitter Housing NEMA 4X Floodproof Sensor Heating
MOUNTING:	**(TRANSMITTER)** **(SENSOR)**	Wall Mount Provide PVC pipe flanges and stilling well in accordance with Manufacturer's recommendations. Terminate stilling well 1 m above finished floor.
ACCESSORIES:		1 - hand-held programmer
MANUFACTURER AND MODEL:		Milltronics OCM111 or approved equal

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I106
DEVICE:	Heating Coil Freezestat
TAG:	U417-TSL U430-TSL U416-TSL U420-TSL
TYPE:	Duct Averaging Vapor-Charged Capillary
SERVICE:	Air handling units
RANGE:	-9.4 to 12.8°C
SETPOINT:	1.6°C trip with manual reset
OUTPUT:	1 N.O. and 1 N.C. contacts with pilot duty rating
POWER SUPPLY:	N/A
ENCLOSURE:	Manufacturer's standard
ACCESSORIES:	Duct mounting kit with sensor element holder

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I107
DEVICE:	Duct Averaging Temperature Transmitter
TAG:	U410-TT-2 U417-TT U416-TT U410-TT-1 U420-TT-3 U420-TT-2 U420-TT-1 U430-TT-1 U430-TT-2
TYPE:	Duct Averaging Platinum RTD Sensor with Transmitter
SERVICE:	Air handling units
RANGE:	-40 to 50°C
INACCURACY:	±0.5% of span or better
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered 8.5 to 35 VDC
ENCLOSURE:	Manufacturer's standard
ACCESSORIES:	Duct mounting kit with sensor element holder

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I108
DEVICE:	Outdoor Air Temperature Transmitter
TAG:	U100-TT-1 U100-TT-2
TYPE:	Platinum RTD Sensor with Transmitter
RANGE:	-40 to 50°C
INACCURACY:	±0.5% of span or better
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
ENCLOSURE:	Stainless steel temperature probe and weatherproof electronics enclosure.
ACCESSORIES:	Wall mount bracket

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I109
DEVICE:	Low Range Differential Pressure Transmitter
TAG:	U410-PDIT U420-PDIT
SERVICE:	Room differential pressure control
RANGE:	0 to 25 Pa differential
PROCESS CONNECTION:	Barbed tube fitting
INACCURACY:	±0.5% of span or better
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
DISPLAY:	4 digit LCD
ENCLOSURE:	Manufacturer's standard
ACCESSORIES:	Wall mount bracket. 5 mm copper sensing lines.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I110
DEVICE:	Differential Pressure Switch
TAG:	U416-PDSH U417-PDSH U420-PDSH U430-PDSH U433-PDSH
SERVICE:	Clogged filter detection
RANGE:	T.B.A., with adjustable trip point
PROCESS CONNECTIONS	Barbed tube fittings on switch and static pressure probes.
INACCURACY:	±1.0% of span or better
OUTPUT:	Form C dry contact rated for pilot duty
POWER SUPPLY:	N/A
ENCLOSURE:	Manufacturer's standard
MOUNTING:	Direct mount static pressure probes to the duct. Wall mount bracket for the switch body.
ACCESSORIES:	Wall mount bracket. 5 mm copper sensing lines.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I111
DEVICE:	Water Temperature Transmitter
TAG:	U455-TT U456-TT U457-TT U460-TT-1 U460-TT-2
SERVICE:	Heating/Cooling Loop Temperature
RANGE:	0 to 100°C
PROCESS CONNECTION:	3/4'" NPT Thermowell with 75 mm insertion
INACCURACY:	±0.5% of span or better
OUTPUT:	4 to 20 mA DC
POWER SUPPLY:	Loop powered
ENCLOSURE:	NEMA 4
MOUNTING:	Direct to process, locate at tee or elbow in system.

INSTRUMENT SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER:	I112
DEVICE:	Line Voltage Room Thermostat
TAG:	U418-TSH
SERVICE:	Electrical from High Temperature
RANGE:	0 to 60°C
INACCURACY:	±0.5% of span or better
OUTPUT:	Form C dry contacts. Rated 10A@120 VAC resistive.
ENCLOSURE:	Manufacturer's standard
MOUNTING:	Wall mount

END OF SECTION

INSTRUMENT LOOP DRAWINGS

1. GENERAL

1.1 References - General

.1 Refer To Section 17010.

1.2 Instrument Loop Drawings

.1 The following Drawings show typical instrument loop wiring diagrams. One (1) Drawing per loop will be completed and submitted for approval after award of Contract. The following twenty (20) Drawings are an integral part of this Specification Section:

ILD-01	Instrument Loop Diagram - Typical Motorized Sluice Gate
ILD-02	Instrument Loop Diagram - Ultrasonic Level Transmitter
ILD-03	Instrument Loop Diagram - Typical Influent Pump Drive
ILD-04	Instrument Loop Diagram - UV System Status
ILD-05	Instrument Loop Diagram - Typical Motorized Weir Gate
ILD-06	Instrument Loop Diagram - Ultrasonic Level Transmitter
ILD-07	Instrument Loop Diagram - Oil Filled Transformer PDT-1
ILD-08	Instrument Loop Diagram - Dry Type Transformer
ILD-09	Instrument Loop Diagram - Intrusion Alarms
ILD-10	Instrument Loop Diagram - Fire Panel Alarms
ILD-11	Instrument Loop Diagram - Typical 4 -20 mA Transmitter
ILD-12	Instrument Loop Diagram - Typical AHU Heater/Chiller Control Valve
ILD-13	Instrument Loop Diagram - Typical HVAC Non-modulating Damper
ILD-14	Instrument Loop Diagram - Typical HVAC Modulating Control Damper
ILD-15	Instrument Loop Diagram - Typical HVAC VFD
ILD-16	Instrument Loop Diagram - Typical HVAC Temp. & Diff. Pressure Switches
ILD-17	Instrument Loop Diagram - Electrical Room Cooling
ILD-18	Instrument Loop Diagram - Electrical Room Exhaust Fan
ILD-19	Instrument Loop Diagram - Typical HVAC FVNR Motor Starter
ILD-20	Instrument Loop Diagram - Heat Pump

2. PRODUCTS

.1 Not used in this Section.

3. EXECUTION

.1 Not used in this Section.

END OF SECTION