TECHNICAL SPECIFICATION SEAL SHEET

Date of Issue: October 2024

CLIENT:	City of Greater Sudbury	**ISSUED FOR THE FOLLOWING PURPOSE(S) ONLY:**	
PROJECT:	Don Lita Station Upgrades	MECP Approval	
CLIENT REF NO.:	ISD24-169	Tender	X
LOCATION:	2226 Hudson Street, Sudbury, Ontario	Building Permit	
		Construction	X

Note: The Professional Seals on this page are in respect to the Technical Specifications comprising Divisions 1 through 16 inclusive. Each seal is limited to the discipline as noted below.

Sheet 1 of 2

FOR SITE CIVIL		
FOR STRUCTURAL		

TECHNICAL SPECIFICATION SEAL SHEET

Sheet 2 of 2

FOR PROCESS MECHANICAL		
FOR ELECTRICAL		
FOR CONTROL & INSTRUMENTATION		
FOR BUILDING MECHANICAL		

DIVISION 1

GENERAL REQUIREMENTS

INDEX

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. This Section includes:

1. Contract method.
2. Work by others.
3. Contractor's use of premises.
4. Owner occupancy.
5. Partial Owner occupancy.
6. Owner furnished items.
7. Available Soils Investigation Report.
8. Provision of Contract Documents.

1.2 RELATED SECTIONS

A. All Divisions and Sections are related to this Section.

B. The General requirements listed herein shall be supplemental to the Special Provisions and General Conditions of the City of Greater Sudbury and are related to Don Lita Lift Station Upgrades.

1.3 CONTRACT METHOD

A. Construct the works under a Lump Sum Price Contract.

1.4 WORK BY OTHERS

A. See the Contract Drawings for other Contracts that are expected to be ongoing during this Contract.

1.5 CONTRACTOR USE OF PREMISES

A. The Contractor shall arrange with the Owner for storage and access.

B. Make arrangements with property owners if additional areas are required. Obtain written agreements.

C. Install and maintain snow fencing along working and storage areas and access routes.

D. Carry out work to minimize inconvenience to the occupants and municipal services of properties adjacent to the works.

E. Store materials separately at locations agreed upon with the Consultant and protect to prevent their deterioration or the intrusion of foreign matter. Remove immediately any material which has deteriorated or been damaged from site at the Contractor's expense.

F. During construction excavation in the vicinity of the facilities, the Contractor shall liaise with the Consultant and Owner to schedule work to minimize impacts on plant operations.

G. The Contractor shall obtain written approval from the Consultant for tie-in work to the existing facilities. Owner staff will operate any valve, switch or other controls on existing facilities.

H. Permanent utilities installed under this Contract may be used for construction requirements provided that no guarantees are affected thereby. Make good any damage.

1.6 OWNER OCCUPANCY

A. Cooperate with the Owner in scheduling operations to minimize conflict and to facilitate the client usage.

B. Maintain free access and parking for the Owner.

1.7 PARTIAL OWNER OCCUPANCY

A. Schedule and substantially perform designated portions of work for City's occupancy before Substantial Performance of entire works.

B. The City will place some equipment into service to maintain operations in accordance with the sequence of construction until issuance of Substantial Performance for the entire works.

C. The Owner will occupy designated areas for the purpose of operation to ensure water quality compliance.

D. In the event of any conflicts between this Section and the General Conditions, more stringent requirements shall apply.

1.8 OWNER FURNISHED ITEMS

A. Incorporate existing infrastructure and materials as shown in the Contract Drawings.

B. The Owner will provide As-Recorded Drawings of the existing facilities, if required by the Contractor.

1.9 AVAILABLE REPORTS

A. Comply with the requirements of the General Conditions and Supplementary General Conditions and Special Provisions.

B. The responsibility to verify subsurface conditions rests with the Contractor.

1.10 PROVISION OF CONTRACT DOCUMENTS

A. The Contractor will be responsible to provide their own copies of the Contract Documents and Drawings, not part of the Executed Contract which will be provided by the City.

B. Additional sets of the Contract Documents and Drawings are available for a non-refundable additional fee of $500.00 per set.

END OF SECTION

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. The following work will be performed as follows:

1. Decommission and demolition of existing dry well, partial removals of existing wet well, and decommissioning and removal of existing equipment.
2. Decommission and removal of existing equipment in generator building.
3. Temporary sanitary sewer bypass system including both permanent and standby power, duty/standby pumping, and automated controls system.
4. Site works, dewatering, shoring, and excavation including monitoring.
5. Partial removal of existing water service and forcemain.
6. Supply and installation of new water service and forcemain.
7. Supply and installation of one (1) pad mounted standby diesel generator.
8. Supply and installation of two (2) submersible pumps in wet well.
9. Supply and installation of new precast concrete valve chamber, including access hatches, stairs, valves, piping, instrumentation.
10. Supply and installation of new external, Pad Mounted Standby Diesel-Powered Generator, Motor Control Centre (MCC), Automatic Transfer Switch (ATS), two (2) Variable Frequency Drives (VFD), Programable Logic Control (PLC) System, and associated power, instrumentation controls equipment.
11. Removal of existing lighting pole, and installation of metering cabinet and cables to utility transformer provided by Greater Sudbury Utilities (GSU), new secondary underground duct banks and cables from utility transformer to Motor Control Centre, and new LED light pole.
12. Start-up, testing, commissioning and training.

B. The description of the work is not, nor is it intended to be, complete and all inclusive.

1.2 SITE OFFICE CONTRACTUAL REQUIREMENTS

A. A site office will be required in accordance Special Provisions of the Contract.

1.3 OPERATIONS PROVIDED BY THE OWNER

A. The Owner will conduct the following operations as per schedule agreed to by the Contractor and the Consultant at no charge to the Contractor:

1. Isolation of existing process piping for new connections.

2. Starting and stopping of existing pumps.

3. Opening and closing of individually commissioned valves in the new works.

1.4 COORDINATION CONSTRUCTION WITH OPERATION OF EXISTING FACILITIES

A. The existing Don Lita Lift Station operates on a continuous and uninterrupted basis, seven (7) days per week, 365 days per year. In the event of conflict between construction operations and routine wastewater supply system operations, wastewater supply system operations have priority. Take every precaution to avoid interfering with routine wastewater supply system operation and maintenance. Reschedule construction operations, as required, without change to the Contract Price.

B. Provide all necessary construction staging, equipment, dewatering, and temporary process fixtures as necessary to provide continuous wastewater flows during temporary shutdown of the existing station in order to facilitate construction of the new works as shown in the Contract Drawings.

C. At least two (2) weeks before the proposed shutdown, submit a detailed schedule including work procedures, prepare Contingency Plans and participate in Planning Meetings with the Consultant and the City, designate foreman and equipment provision. Allow for a “dry run”, 48 hours before the shutdown. All personnel, equipment and materials shall be on-site and shall participate in the “dry run”.

D. Where Owner staff is required for co-ordination of works such as equipment demonstrations, commissioning and system integration, this work shall be scheduled during normal operation hours of 8:00 a.m. to 4:30 p.m. Should the Contractor require Owner staff to work beyond normal work hours, overtime costs will be billed and paid by the Contractor within a reasonable timeframe.

E. The Contractor is hereby notified that the City reserves the right to stop work at the Don Lita Lift Station at any time. The Contractor will not hold the City responsible for lost time and/or costs associated with a stoppage of work.

F. No extra payment will be allowed for the following:

1. Approved system interruption schedule submission.

2. Schedule resubmissions until approved by the Owner and Consultant.

3. All required co-ordination and liaising.

4. Off-peak hours work, nighttime work, and/or weekend/Statutory Holiday work.

G. Schedule tie-ins to other existing structures and services based on the following constraints:

Process/Wastewater Supply System Services	Constraints for Tie-Ins Requiring Major Shutdowns
Wastewater flows on a continuous basis.	Contractor will be required to provide the City a minimum of 72-hour notice of any process shutdowns or as otherwise directed by City Operations.

H. Coordinate other tie-ins, other than noted above, with the Consultant and Wastewater Supply System Supervisor. Wastewater supply system operations must comply with the Environmental Compliance Approval (ECA), issued by the Ministry of Environment, Conservation and Parks (MECP). Unscheduled tie-ins and disruptions to wastewater supply system operations could result in noncompliance with this certificate resulting in possible fines. The Contractor is liable for any adverse effects their actions have on wastewater supply system operations and compliance with the ECA limits.

1.5 MANAGEMENT, COORDINATION, SCHEDULING AND CONSTRAINTS

A. The Owner will not permit any change to the constraints listed in this entire Specification Section.

B. Designate an individual to be responsible for management, coordination and integration of the new and existing works. The responsibility of this individual shall include, but is not limited to, the following:

1. To manage, coordinate and supervise process tie-ins.

2. To act as a direct liaison with Operations staff once approvals have been obtained from the Wastewater Supply System Superintendent and/or Consultant to perform work that will interrupt operation of the existing water supply system.

C. Coordinate activities on the site and in existing facilities including pipe connections, building connections, mechanical and electrical connections with the Owner or their designated staff.

D. Coordinate and schedule all works with the minimum possible disruption and impact to the normal operations of the existing sites.

E. Prior to any shutdown of the existing facilities, the following requirements must be observed by the Contractor in completing the work:

1. The Contractor must submit to the Consultant in writing the proposed method, indicating in detail, the procedures proposed to accomplish each portion of the work that requires an interruption to the operation of the existing wastewater supply system. The proposed method of construction must be forwarded to the Consultant (including Stamped/Signed Drawings for design) with at least four (4) weeks in advanced notice before commencing the work. The Contractor shall not begin any such work until he has received written acceptance of the methodology and approach from the Consultant. The Contractor shall include in their plan the specific number of work hours to complete each facility interruption.

2. Prepare a separate Work Plan for electrical and control systems tie-ins.

3. Prepare and submit a Contingency Plan for all proposed installations, alterations, and/or removal procedures in the event that working time exceeds what was expected or in the event anticipated operating conditions are changed.

4. All partial shutdowns for equipment installation and/or removal and new piping and/or services and connection work must be approved in advance by the Consultant. Make provisions for temporary diversion piping, temporary pumping, and temporary power supply.

5. All temporary equipment, tools, materials, labour, and miscellaneous equipment must be scheduled and available at the work site in advance of any shutdowns.

6. The Contractor is fully responsible to permanently or temporarily revise proposed or existing works in order to execute the necessary shutdowns and major tie-in work of the Contract.

7. The Owner is responsible for operating all valves and equipment in the existing works. The Operator will only operate equipment, within the boundary of the works, under the supervision of the Contractor. The Contractor shall not operate existing wastewater supply system equipment.

8. The Owner reserves the right to cancel any scheduled shutdown if wastewater system or weather conditions dictate, if wastewater flows are excessive, at no additional cost to the Owner and at the sole discretion of the Operator.

9. The Contractor may be required to undertake tie-in/shutdown work in early morning hours, i.e., midnight to 8:00 a.m. inclusive or as otherwise directed by the Owner, to take advantage of low flow periods. The costs for working during off-hours are to be included in the Tender Price**.**

F. At each location where tie-in is required, provide a complete system of temporary works including bulkheads, piping, pumps (duty/standby), power (both permanent and standby), automated controls and communications, equipment, watertight separations and labour as necessary to maintain lift station flow/operations and allow construction of the new structures.

G. The Contractor is solely responsible for developing appropriate schemes for temporary works, within the constraints, that meet both wastewater system operation and construction needs.

H. Coordinate Project Execution and schedule all activities within the above-mentioned wastewater operating constraints and the items for consideration presented in the next Subsection.

1.6 LIMITS OF CONSTRUCTION

A. Provide temporary construction fencing within property and work areas as outlined on the Contract Drawings to suit construction.

B. Provide temporary construction fencing to suit all necessary temporary works.

C. Apply, obtain and pay for all necessary permit(s).

D. Minimize impacts on current wastewater operations.

1.7 CONSIDERATIONS FOR DEVELOPING SEQUENCE OF WORK

A. The Contractor is responsible for developing the sequence of work, within the constraints described in this Section, to meet both wastewater system operations and construction needs.

B. The Consultant will review the Contractors construction sequence and schedule so as to minimize impact on operations, subject to approval of the Owner.

C. Maintain fire and maintenance access/control at all times.

D. In addition to the constraints described herein, the following information on the work to be undertaken is provided to assist the Contractor in developing a sequence of work. The information presented is not prescriptive. Work may proceed concurrently or separately in each area and may need to be adjusted to suit water supply process timing restrictions, seasonal conditions and equipment delivery restrictions. Work may proceed independently in each area exclusive of constraints and tie-in restriction noted:

1. Ensure strict adherence to the Wastewater Safety Standards and the Occupational Health and Safety Act.

2. Comply with Ministry of Labour requirements.

3. Minimize the number of disruptions to current wastewater operations.

4. The wastewater operation is responsible for complying with the Environmental Compliance (ECA) limits during the construction period. The ECA requirements takes precedence over work under this Contract.

5. Contractor is fully responsible for equipment operation until they are fully commissioned. Since this is a phased installation, a tagging system will be employed to delineate the areas of responsibility for equipment and valve operation.

6. Contractor is responsible for cleaning tanks, channels, piping and other equipment that will be retrofitted including disposal all materials subject to review and approval by the Owner.

7. Contractor is responsible for maintaining the integrity of all existing equipment, piping, valves and chambers that will be use for new tie-ins.

1.8 COORDINATION OF TRADES AND CORRELATION OF ELECTRICAL CONTROL

A. Coordinate architectural, process, mechanical, electrical, instrumentation and controls, and structural work for equipment being installed; provide openings and embedments in existing walls and structures for pipes and conduits. Cut and make good, or excavate and backfill, as required and in a timely manner so that the work proceeds expeditiously.

B. Control equipment and wiring systems, specified or shown on Electrical Drawings for electrically operated equipment, are designed for the process mechanical equipment as specified or as may be necessary for future requirements.

C. Should the Contractor wish to provide alternate process mechanical equipment requiring changes to electrical equipment, wiring or associated raceways, the Contractor shall bear the extra expense for such changes to the electrical control equipment or wiring systems if such equipment is accepted by the Consultant as set out in the General Conditions and Form of Tender.

1.9 EXISTING SERVICES

A. Consult all local, public and service utility companies records and become fully informed of the locations and extent of all utilities.

B. Disconnect or relocate all public utilities encountered in connection with the work. Send proper notices, make all necessary arrangements and provide all services and work required in the case of gas mains, water pipes, sewers, telephone and telegraph conduits and cables, fire hydrants, lamp posts, sign posts and any other items of like character.

C. Should any piping, sewers, cables or similar services be encountered during the work of this Contract that are not known from the Owner or other utility companies records, notify the Consultant and do not proceed with their removal or cutting until directed.

1.10 WORK IN EXISTING BUILDINGS

A. Where existing, active mechanical, electrical or other services, concealed or exposed, extend through or are within an area to be renovated, relocate such services to suit the renovation work and new finishes, and include for concealing existing services behind new finishes wherever they would be exposed in new finished areas.

B. Carefully remove existing fixtures, equipment, construction and finishes shown on the drawings to be removed employing experienced tradesmen. Salvage, identify and store the products that are to be reused or delivered to the Operations Contractor.

C. Where mechanical or electrical fixtures and equipment are removed, cut back obsolete piping, ductwork and conduit behind finishes unless otherwise noted, and cap. Cap piping watertight. Remove obsolete wiring back to its source. Provide blank coverplates on obsolete outlet boxes.

D. Act as a Fire Warden for the Contract.

E. Be responsible for and enforce Fire Protection Methods and Procedures and adherence to local Fire Regulations, including requirements of the Occupational Health and Safety Act.

F. Ensure the existing fire protection and alarm systems are not obstructed, shut-off or made inactive at any time. Do not use any fire hydrant, standpipe or hose system for other than fire protection purposes.

1.11 EXISTING ROADS

A. Repair any damage and reinstate roads damaged during construction to original condition.

B. The Contractor shall choose and operate all equipment to avoid any damage to existing roads. Any existing asphalt, concrete curbs and sidewalks, shoulder or grass areas, which are damaged by the Contractor due to their operation, will be replaced by the Contractor to the satisfaction of the Owner at the Contractor's cost. Concrete sidewalks and curbs which are damaged by the Contractor have to be removed from joint to joint and reconstructed to the requirement of the applicable governing authority.

C. The Contractor will be responsible for daily washing and sweeping of all roads adjacent to construction sites and affected by construction dust, mud and debris at the sole discretion of the Consultant.

1.12 EXISTING DIMENSIONS/ELEVATIONS

A. Dimensions shown are based on existing Drawings and are approximate. Verify field dimensions, elevations, and details before commencing work. Report discrepancies to the Consultant.

1.13 FACTORY PAINTING OF EQUIPMENT

A. Factory paint all equipment and miscellaneous metal supplied under this Contract with one coat of primer, which will be part of permanent protective coating system, unless otherwise specified.

B. Before application of prime coat, clean and prepare surface to requirements specified in applicable protective coating system.

C. Special factory-applied coatings required (for example, for corrosion resistance, high temperature, etc.) are specified in Equipment Specifications.

1.14 COOPERATION WITH OTHER CONTRACTORS

A. Other Contracts may be awarded or underway at other locations on the wastewater site. The Owner will provide a list of Contracts at the first Pre-Construction Meeting.

B. Ensure strict compliance with the Ministry of Labour requirements governing the completion of multiple Contracts. Each Contractor will have to coordinate their work, to ensure separate time and space.

C. Only use dedicated access gates.

D. Work and mobility of this Contract to stay within the limits of site work shown on the Contract Drawings.

E. Contractor will keep a log book, as per the requirements of the Owner, to record the name of all workers that are working on the site on a daily basis. This is required to notify the workers in the event of a wastewater emergency.

F. At the interface with other Contracts, jointly plan and coordinate with other Contractors the work so that the project:

1. Will not be delayed.

2. Will not be endangered in any way.

3. Will be correctly connected.

4. Will not cause the Owner to be designated as the Constructor (through Contractor's non-compliance with Ministry of Labour requirements for separation in space and/or time between different Contracts).

END OF SECTION

PART 1. GENERAL

1.1 INTENT

A. This Section covers the environmental protection requirements during construction.

B. The Ministry of Environment Regulations and associated Environmental Protection Plans (EPPs) shall govern the environmental protection requirements.

C. The provisions of this Section are in addition to the provisions of other Sections of this Contract.

1.2 GENERAL PROVISIONS

A. Be responsible for the protection of the natural environment of the site and surrounding areas, both land and water. Protection of the environment must start with avoidance and prevention, and then control/mitigation, compensation or enhancement (in order of descending preference).

B. Project construction activities must be carried out in compliance with all applicable environmental laws and regulations.

C. All materials (hazardous and non-hazardous) will be handled so as to protect human health and the environment.

D. Activities will be planned and implemented, and equipment will be managed and maintained in a manner that minimizes air emissions.

E. Prevent the accidental discharge of contaminants into soils, surface water and/or groundwater. Any accidental contamination will be reported to the Ministry of the Environment and cleaned up as per provincial requirements.

F. The Contractor is responsible for conforming to the City's policies for addressing waste management. Non-hazardous wastes produced by the Project will be disposed of according to the Owner's approved procedures for disposal and any hazardous wastes produced will be managed in accordance with applicable laws and regulations.

G. Erosion control measures will be designed, implemented and maintained to ensure that there is no increased sediment loading to surface waters leaving the Project site. The Contractor is responsible for ensuring that the erosion control measures are implemented and maintained throughout the duration of Project.

1.3 ENVIRONMENTAL MANAGEMENT PERSONNEL

A. The Contractor is responsible for designating an Environmental Monitoring Supervisor who will be responsible for the daily implementation of the Environmental Management Personnel (EMP) to ensure that the environmental protection measures are properly implemented and maintained. This will involve ensuring that the EMP's guiding principles and objectives are taken into account in all daily project activities and fulfilling the requirements of environmental compliance monitoring. Specifically, the Environmental Monitoring Supervisor will be responsible for:

1. Overseeing all construction activities to ensure compliance with the environmental protection measures outlined in the EPPs.

2. Reporting all environmental concerns to the Engineer or their delegate for immediate action.

3. Implementing the appropriate Contingency and Emergency Response Plans as required to address failures in the environmental protection measures (if required) in a timely fashion.

4. Training all on-site personnel on their environmental responsibilities and duties (including Emergency and Contingency Response Plans) and the implementation, monitoring and maintenance of the environmental protection measures.

5. Ensuring that the weekly inspection logs are filled out and the results are analyzed and reported to senior management (by means of the monthly environmental inspection reports) in accordance with the reporting requirements.

6. Ensuring that the environmental inspection records are consistent with the environmental Quality Control (QC) reporting requirements.

7. Implementing environmental QC throughout construction.

1.4 CONSTRUCTION AREA

A. Confine construction work area as shown on Drawings, and erect suitable barricades to protect areas on which no work is designated to be performed.

B. Submit to the Consultant for review, Plans and Sketches showing areas proposed to be used for construction, storage and access, including dimensions of these areas and show the location and size of all trees within and adjacent to these areas.

C. Store equipment and materials in an orderly manner and in locations acceptable to the Consultant.

D. Open fires and burning of rubbish are not permitted on the site.

1.5 ENVIRONMENTAL INSPECTION AND MONITORING

A. The Contractor is responsible for conducting ongoing environmental inspection and monitoring to ensure compliance with the required mitigation measures set out in the EMP and EPPs. This shall include identification of the appropriate remedial actions where required and implementation in a timely fashion.

B. Be advised that inspectors from the Ministry of the Environment and other authorities may make periodic visits to the site during construction. They have the power to order the Contractor to stop work if the work, in their opinion is not being done to ensure compliance with environmental objectives. The Engineer's acceptance of the work may be withheld until the Ministry or other authorities concerned have issued their approval.

1.6 INCLEMENT WEATHER

A. Ensure adequate environmental protection and take precautions at times of inclement weather (e.g., ensure erosion and sedimentation control measures are functioning effectively and install additional measures as necessary).

B. Inclement weather or extra work caused by such weather will not be accepted as reason for additional payment or an extension to the Time for Completion.

C. Do not occupy or use any part of the site in such a way as to interfere with the operation of the existing plant or with work being carried out by others.

D. Provide parking within the working limits or other areas specifically designated for parking and shown on the Drawings for owned vehicles and for those of sub-trades. Erect signs to direct construction traffic.

1.7 SURFACE DRAINAGE AND EROSION AND SEDIMENT CONTROL

A. All work is to be in accordance with MECP and MNR Guidelines.

B. Maintain existing ditches and watercourses for surface water drainage of the site and external properties during construction and bear the responsibility for damage that may result by reason of not doing so.

C. Only clear, grub and strip topsoil from areas of the site immediately before commencing work in those areas. Do not allow large areas of the site to lie cleared, grubbed and stripped of topsoil unless work is progressing in those areas.

D. Incorporate the appropriate erosion and sediment control measures to ensure that sediment and other debris are not discharged to the adjacent ditches and watercourse. This shall include silt fencing, straw bale or rock check dams, etc., as necessary to capture all sediment and debris within the area of construction. The Contractor is responsible for inspecting and maintaining these control measures to ensure proper function and adequate sediment storage at all times (sediment is to be removed once it reaches 50% of the capacity of the structure).

E. Locate and protect stockpiles of a semi-permanent nature by encircling them with silt fencing to the satisfaction of the Engineer to ensure minimum environmental interference.

1.8 DEWATERING AND DISCHARGE

A. Apply for and obtain a Permit to Take Water from Local Office of the Ontario Ministry of the Environment, Director, Permit to Take Water Program.

B. If dewatering is required, apply and obtain dewatering discharge approval from the Ministry of the Environment, Conservation and Parks to comply with Sections 16 and 24 of the Ontario Water Resources Act. Discharge all water from dewatering operations to meet Ontario Provincial Regulations before discharge.

1.9 TREES

A. No trees are to be cut down unless shown on the Drawings or designated by the Consultant.

B. Take precautions to prevent damage to existing trees and shrubs, protect branches and foliage, protect trunks and stems, prevent machinery from travelling over roots within the 'drip line' of the trees by placing and maintaining snow fencing around each tree outside of the ‘drip line’. Do not pile excavated material within the ‘drip line of existing trees.

C. Where damage does occur, it must be reported to the Consultant and repaired or replaced by a qualified person as directed by the Consultant.

D. Where trees or shrubs are damaged beyond recovery and cannot be replaced by similar plant material of the same type and size, pay penalties as established by the International Society of Arboriculture’s booklet entitled 'A Guide to Professional Evaluation of Landscape Trees, Specimen Shrubs and Evergreens'.

1.10 NOISE CONTROL

A. Adhere to local noise control by-laws.

B. Equip vehicles and motorized equipment with efficient muffler devices to minimize noise levels in the vicinity of the site. Maintain muffler devices in proper working order.

C. No excessive idling of motorized equipment is permitted.

D. Where necessary, place noise attenuation devices (barriers) around Contractor's construction equipment.

1.11 CLEANING EQUIPMENT

A. Keep construction equipment clean so that no debris is deposited on the plant roadways or any public roadway. Identify a designated vehicle cleaning area within the working limits of the Contract. Contain all construction debris in this designated area only. Dispose of debris off-site as specified.

B. Ensure that debris cleaned from equipment cannot gain access to storm sewers and watercourses.

1.12 MUD AND DUST CONTROL AND DEICING AGENTS

A. Undertake dust control measures to prevent dust nuisances from any phase of the construction operation.

B. The Contractor shall employ only wet type equipment for saw cutting, concrete grinding to control dust nuisance.

C. All trenches and disturbed areas by construction works that will produce dust shall be maintained dust free by an application of calcium chloride at the Consultants orders. The calcium chloride and application of same shall be paid under the appropriate items in the Form of Tender.

D. Obtain Consultant's acceptance before chemicals for dust control are used. Sodium chloride is not permitted for dust control.

E. Transport dusty materials in covered haulage vehicles.

F. Transport wet materials in suitable watertight haulage vehicles.

G. Do not use calcium chloride on access roads.

H. Prevent contamination of cast-in-place concrete by deciding agents.

I. The Contractor shall be responsible for a prompt and complete clean up of all dirt and mud deposited on the public and/or private property as a consequence of their operation on this Contract. In the event the Contractor fails in this obligation the Owner and/or Consultant may proceed with the necessary clean up and charge all the costs for the work to the Contractor.

1.13 EQUIPMENT FUELLING, MAINTENANCE AND STORAGE

A. Designate an area within the working limits to be used exclusively for fuelling construction equipment. Obtain Consultant's acceptance of refueling areas. Carry out all refueling in this area only.

B. Submit to the Consultant for review before starting works, procedures for the interception and rapid clean-up and disposal of fuel spillages which may occur.

C. Ensure the materials required for the clean-up of fuel spillages are readily accessible on site at all times.

D. Refuelling of backhoes or shovels will be allowed at locations other than the accepted refueling areas, but not closer than 10 m from any watercourse.

E. The cleaning of equipment in streams and lakes and the emptying of fuel, lubricants and pesticides into watercourses is prohibited. Contain construction debris and dispose of it in approved locations.

1.14 RESTORATION

A. In general, restore the site to condition equal to or, if specified elsewhere, to a condition better than existing conditions.

B. Restore lands outside of the limits of the work which are disturbed by the work to their original condition.

1.15 CONTINGENCY AND EMERGENCY RESPONSE PLANS

A. To fulfill its commitment to protecting public and worker health and safety, and the environment, the Contractor is required to adopt a preventative strategy. Through this strategy, the potential issues and emergency events that can be anticipated will be identified and procedures put in place to minimize their potential occurrence.

B. To address the unanticipated events, the Contractor is required, as part of fulfilling its environmental commitments under the EMP, to develop Contingency and Emergency Response Plans and implement these plans as part of its Contract with the Owner for undertaking the Project.

1.16 SPILLS RESPONSE PLAN AND SPILLS REPORTING

A. Before commencing construction, the Contractor is responsible for preparing a Spills Response Plan. The Spills Response Plan must address the response, containment, and cleanup of an accidental spill. It must take care of the specific roles and responsibilities of construction staff, accountability, reporting and documentation. Specifically, the plan must include:

1. The names and the telephone numbers of the persons in the local municipalities to be notified forthwith of a spill.

2. The names and the telephone numbers of the representatives of the fire, the police and the health departments of the local municipalities who are responsible to respond to emergency situations.

3. The names and the telephone numbers of the companies experienced in the control and clean-up of hazardous materials that would be called upon in an emergency involving a spill.

4. The Contractor's proposal for the immediate containment and control of the spill, the Clean-Up Procedures to be initiated immediately and any other action to be taken to mitigate the potential environmental damage while awaiting additional assistance.

5. The name and the telephone number of the Contractor's representative responsible for preparing, implementing, directing and supervising the Contingency Plan.

B. In the event of a spill or other emission of a pollutant into the natural environment, every person responsible for the emission or who causes or permits it must forthwith notify the following of the spill, of the circumstances thereof, and of the action taken or intended to be taken with respect thereto:

1. The Ministry of the Environment, Conservation and Parks.

2. The Corporation of the City of Greater Sudbury.

3. The person having control of the pollutant, if known.

4. The Owner.

5. The Consultant.

C. The Contractor must make the necessary allowances to ensure the immediate availability of the products with which to effect temporary repair to broken pipelines and other services, so the spill or other emission of a pollutant is immediately controlled and stopped and to mitigate the damages.

D. Submit for the Consultant's review and the review of other responsible parties a copy of the plan and make the appropriate changes to it based on review comments received.

1.17 EROSION AND SEDIMENT CONTROL CONTINGENCY PLAN

A. If the erosion and sediment control measures are damaged or fail the Contractor is responsible for the rapid and effective response to such events is essential to minimize the introduction of sediments to aquatic systems. These measures are to include the installation of straw bales, silt fencing or other suitable material to filter flow or create a barrier to direct flow or provide containment below a failed sediment control fence or check dam.

B. The Contractor is responsible for developing the plan (the key elements of the plan are outlined in the EMP).

1.18 FIRE CONTINGENCY PLAN

A. The purpose of the Fire Contingency Plan is to ensure a rapid response to a fire thereby minimizing the threat to worker and public safety, and the environment.

B. The plan must include but is not limited to: an explanation of the purpose of the plan and when the plan is triggered; an explanation of roles and responsibilities, and accountability for implementing the plan; and provision of fire prevention training and equipment for implementing the plan.

C. The Contractor is responsible for developing the plan (the key elements of the plan are outlined in the EMP).

1.19 CONTAMINATED SITES CONTINGENCY PLAN

A. The Contractor is responsible for having an approved Contaminated Sites Contingency Plan to ensure that potentially contaminated sites are recognized and properly managed to ensure environmental protection and worker safety.

B. The plan must include (the key elements of the plan are outlined in the EMP), as a minimum, the following steps for responding to the discovery of contaminated soils (or suspected because they appear unusual either visually or through odour) during construction:

1. Immediately stop all work in the vicinity of the discovery and secure the site. The Environmental Monitoring Supervisor is responsible for ensuring that the site is secured and that the appropriate response is initiated.

2. Always assume the worst case and stay upwind of the contamination and assess the situation from a personal and public safety perspective. If in doubt, personnel should stay away from the site. Cordon off the scene and prevent people from coming in contact with the contaminated materials until it is determined that it is safe to do so.

3. Notify the Consultant and the Owner.

C. The Owner will clean-up the site at no cost to the Contractor and the Contract time may be extended for such reasonable time where it can be demonstrated by the Contractor that this work has been delayed by the cleanup. The Owner shall not be liable for any other costs, such as delay or impact, as a result of having to clean-up the additional toxic or hazardous substances and material from the site.

1.20 HISTORICAL RESOURCES CONTINGENCY PLAN

A. The following key steps must be taken to protect any archaeological resources that are unearthed:

1. If a suspected find is unearthed, work in the vicinity of the find will be stopped and the Environmental Monitoring Supervisor, Consultant and Owner notified.

2. Notify the office of the Regulatory and Operations Group, Ministry of Culture immediately.

3. In the event that human remains are encountered during construction, both the Ministry of Culture and the Registrar or Deputy Registrar of the Cemeteries Regulation Unit, Ministry of Consumer and Commercial Relations should be notified immediately.

4. Work at the site of the find will not commence until the discovery has been satisfactorily dealt with and the Ministry of Culture authorizes resumption of work.

B. The Contractor is responsible for developing the plan (the key elements of the plan are outlined in the EMP).

C. The Owner will be responsible for retaining the services of an Archaeologist at no cost to the Contractor and the Contract time may be extended for such reasonable time where it can be demonstrated by the Contractor that this work has been delayed by the cleanup. The Owner shall not be liable for any other costs, such as delay or impact, as a result of archaeological resources unearthed during construction activities.

1.21 IMPLEMENTATION OF THE CONTINGENCY AND EMERGENCY RESPONSE PLAN

A. The responsibility for implementing the Contingency and Emergency Response Plans lies with the Environmental Monitoring Supervisor. Specific responsibilities include:

1. Reviewing the Contingency Plans and Emergency Response Plans and identifying any issues/concerns and providing suggested changes/updates.

2. Ensuring that all construction staff are trained in Contingency Plan implementation and emergency response techniques and that they have the appropriate equipment on hand.

3. Providing advice to construction staff on proper Emergency Response Procedures.

4. Auditing the Contractor's response to events resulting in the activation of its Contingency Plans and Emergency Response Plans.

5. Initiating actions to correct any response deficiencies identified through the audit process and reporting it.

6. Maintaining emergency response records for review by the Consultant and the appropriate regulatory agencies.

1.22 ENVIRONMENTAL AWARENESS TRAINING

A. The Contractor is responsible for developing and implementing environmental awareness training to ensure that all on-site personnel are aware of environmental sensitivities associated with their actions; their roles and responsibilities in protecting the environment; and the mechanisms available to them to carry out their environmental protection responsibilities. The Training Program must include specific Environmental Awareness Programs for the various Contingency and Emergency Response Plans developed for the Project. The key elements and requirements of the plan are outlined in the EMP.

B. The Contractor is responsible for submitting the Training Program for the Consultant's review and approval. The appropriate changes are to be made based on the review comments received. Once approved, the Environmental Monitoring Supervisor is responsible for ensuring that all on-site personnel undergo environmental awareness training before working on the site.

1.23 SUBMITTALS

A. Before commencing any work on this Contract, submit six (6) copies of the Environmental Protection Shop Drawings for the Consultant's review and approval.

B. Submit Shop Drawings in accordance with the requirements of Section 01330 – Submittals.

C. Submit separate Shop Drawings for each of the following:

1. Plans and Sketches showing areas proposed to be used for construction storage, the Contractor's site office, vehicle cleaning, equipment fuelling and associated access routes.

2. Surface Drainage and Erosion and Sediment Control Plan.

3. Mud and Dust Control Plan.

4. Spills Response and Spills Reporting Plan.

5. Erosion and Sediment Control Contingency Plan.

6. Fire Contingency Plan.

7. Contaminated Site Contingency Plan.

8. Historical Resources Contingency Plan.

9. Fuel Spills Contingency Plan.

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. Comply with General Conditions and related Sections.

B. Comply with working procedures as stipulated by the City of Greater Sudbury General Conditions.

C. Comply with applicable Environmental Health and Safety Standards, Legislation and Regulations.

1.2 RELATED SECTIONS

A. Section 01351 – Health and Safety.

1.3 REFERENCES

A. CSA C22.1 Canadian Electrical Code.

B. Health and Safety Regulations.

C. Occupational Health and Safety Act.

D. Environmental Health and Safety Policy of the City of Greater Sudbury.

1.4 HEALTH AND SAFETY

A. Comply with work procedures as per Section 01351.

1.5 ENVIRONMENTAL CONTROLS

A. Comply with work procedures as per Section 01061.

1.6 EXPLOSIVE-PROOF CONSTRUCTION

A. Certain areas may be designated on the Drawings and Specifications as "explosion proof", "hazardous", or may be classified under Section 18 of CSA-C22.1. Where areas have such designation, provide explosion proof electrical equipment, devices, wiring and installation which meets the requirements of CSA-C22.1, Section 18 and carry the appropriate CSA approval.

B. In hazardous areas as defined above, provide intrinsically safe mechanical devices and equipment such as non-sparking aluminium wheels for fans, pneumatic operators for dampers and aluminium clappers for check valves on pipelines conveying gaseous fuels.

C. Provide, mount and maintain signs warning of all hazards and the proper procedure required for working in the hazardous areas.

D. Note the existing gas lines passing through the work area may need to be maintained in service during the construction. Take suitable safety precautions to protect personnel and to protect these services from damage during the work.

1.7 WORK NEAR EXISTING FACILITY

A. Carry out all removals, temporary or permanent and to provide temporary services needed to implement the work included in the Contract as needed to maintain operation as required.

1.8 DESIGNATED SUBSTANCES

A. If a designated substance is located during the Project, stop work in that area and immediately notify the Consultant or the Owner. Refer to Part #1 Instruction to Bidders.

1.9 ASSISTANCE

A. Give reasonable help to the Consultant's services staff in checking the setting out of the work. Arrange for ready access to work.

1.10 HOT WORK PROCEDURES

A. Observe rules of the Occupational Health and Safety Act.

B. Establish and implement written procedures for Hot Work. Provide a copy of these procedures to the Consultant.

C. Prior to starting any work which requires welding, cutting, open flame or heat, submit Hot Work Notice to plant operations for review of location and timing.

D. Provide and maintain suitable firefighting equipment when performing hot work. Train Contractor's personnel working in these areas in the use of firefighting equipment.

E. Whenever soldering, welding or any open flame work is performed, ensure the area is suitable for such work, ensure the proper incombustible shields are provided to protect combustible products and materials and have an observer present at all times to ensure adjacent products and materials are not ignited and welding, soldering or open flame work do not produce a hazardous condition.

F. A copy of the Hot Work Notice is attached to the end of this Section.

1.11 HOLES IN EXISTING CONCRETE

A. When it is required to make new holes in existing concrete for piping, conduit, cables, or equipment, using either method described below:

1. Accurately and carefully mark out the locations and the extent of cutting required and coordinate with the trade(s) involved.

2. Prior to drilling any openings, determine the location, if any, of existing services concealed in and/or behind the construction to be drilled. X-ray the walls or slabs, if required.

3. Chip with an electric hammer with chisel point. Adjust the location of holes as necessary to avoid electrical conduits if encountered. Cut reinforcing steel after permission is received.

B. Radiograph the existing concrete for 3 diameters around the centreline of the proposed penetration. If no structural steel, piping or electrical conduits are found, core the hole. If structural steel, piping or electrical conduits are found, select an alternative location and radiograph it. If structural steel, piping or electrical conduits are found, do not core unless written permission from the Engineer is received.

C. Prior to commencing work, submit to the Consultant a photocopy of the license issued under the Atomic Energy Control Board Regulations for radiography. Perform work in accordance with current Atomic Energy Control Board Regulations for radiography. Be responsible for boundary controls, signs that protect the personnel and others from hazards in the radiograph work area. Inform the Consultant in writing 48 hours prior to commencing any radiography.

D. Unless otherwise noted, where drilling is required in waterproof slabs, size the openings to permit snug and tight installation of a pipe sleeve, which is sized to leave 12 mm clearance around the pipe or pipe insulation. Provide a pipe sleeve in the opening. Pipe sleeves are to be schedule 40 galvanized steel pipes with a flange at one end and a length to extend 100 mm above the slab. Secure the flange to the underside of the slab and caulk the void between the sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a watertight installation.

1.12 PROTECTION, SOUNDNESS, AND REPAIR OF NEW CONSTRUCTION

A. Protect newly constructed work from damage. Prevent heavy loading of newly constructed work and repair damage. Construct works watertight and correct rejected work.

B. If, in the final inspection, deficiencies are found, repair or replace defective work. Be responsible for satisfactory maintenance and repair of work undertaken for the specified guaranteed maintenance period. Protect and store equipment supplied under this Contract.

1.13 UNWATERING EXISTING STRUCTURES AND PIPELINES

A. Be responsible for unwatering existing structures, channels, pipelines and tanks as required to facilitate construction.

B. Provide and install bulkhead plates in existing guides. Provide connections and seals for bulkheads where guides are not available. Provide temporary pumps to unwater and control water levels in existing structures, channels and tanks. Discharge pump flows to tanks or channels in service as directed by Consultant.

C. Empty pipelines by draining to existing sumps, if available. Provide temporary sump and pump if an existing sump is not available. Flush pipelines clean of sludge prior to making connections.

1.14 STORAGE AND PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be governed by the direction of the Owner or Consultant in all matters connected with or concerning storage of machinery, materials and supplies along the line of work and shall at his own cost shift or remove such machinery, materials and supplies immediately upon notice from the Owner or Consultant and to location or locations acceptable to the Owner or Consultant.

B. Arrange for delivery to the site, and protection of materials and equipment:

1. Schedule delivery of equipment only when building is far enough advanced to protect units from weather and construction dust and debris.

2. Provide equipment and labour to unload, move and place units in final position.

3. Protect materials and equipment from damage.

C. Specification Sections may contain additional requirements for delivery, storage and handling. Provide additional delivery, storage and handling requirements to meet these additional requirements.

D. Protect materials and equipment after unloading from weather, dust, dirt and moisture both before and after erection and placing. Observe Manufacturer's written instructions for temporary storage.

E. Provide dry heated $10^{O}C$ temporary housing for pumps, motors, valves and other equipment or materials which may be injured by weather, dust, dirt or moisture.

F. Maintain shafts and bearings in good condition by rotating weekly.

G. Provide Manufacturer's written instructions for the storing of equipment during the construction period well in advance of equipment delivery.

H. Store specially items to ensure protection from damage to materials or finish.

I. Store materials subject to water absorption off the ground. Protect materials from other damage due to environmental conditions under waterproof covers.

J. Promptly as work proceeds and upon completion, clean up and remove from site surplus materials resulting from foregoing work.

1.15 PRECONSTRUCTION SURVEY

A. Comply with the requirements of the Special Provisions and Section 01330 – Submittals.

B. Prior to construction, undertake pre-construction surveys with the Consultant and the Owner.

C. Undertake a survey of existing surface finish conditions.

D. Document findings with video, photographs and in writing.

E. Be responsible for repairing damage due to construction.

F. Submit a copy of the report with video and photographs to the Consultant.

1.16 PROTECTION OF EXISTING STRUCTURES AND PROPERTY

A. The Contractor will be held fully responsible by the Owner for any damage to utilities, equipment, properties, buildings, homes or structures adjacent to or in the general area of the work, through settlement of ground, vibration or shock, flooding resulting from any cause relating to the work carried out under this Contract. Make good and repair such damage at own expense.

B. Should the Contractor require the use of Owner’s equipment located on site, the equipment will be handed over only after being certified by the Owner. The Owner will not be responsible for the equipment once in the Contractor’s use. Any lifting equipment, etc., will be the Contractor's responsibility to have re-certified to ensure that the equipment’s condition is the same as when it was originally given to the Contractor. Any damage to the equipment will be the sole responsibility of the Contractor to repair or replace at no cost to the Owner.

C. Control of Vibrations:

1. Control vibration levels to prevent damage to concrete work during construction, existing structures, equipment, and utilities. Refer to Sections 02020, 02030, 02040 of the Contract Specifications.

2. Control use of vibration producing construction techniques or equipment so that the ground adjacent to concrete has a resultant Peak Particle Velocity (P.P.V.) not exceeding the following limits:

Age of Concrete (Hours)	Maximum Permissible Resultant P.P.V. (mmlS)
Less than 4	50
4 to 60	10
Over 60	50

3. Schedule and execute placing of concrete so that, for concrete 4 to 24 hours old, a minimum distance of 40 m between the source of vibration and the concrete is maintained.

4. The Owner may retain the services of an independent inspection agency to monitor vibration effects.

5. The Consultant reserves the right to require additional restrictive limits for vibration control if recommended by the inspection agency.

D. Sustain in their places and protect from direct or indirect injury, water and gas mains, public and private sewers and drains, conduits, cables, service pipes, poles, sidewalks, curbs, embankments, structures, equipment and other property in the vicinity of the work.

E. Protection Against Flooding:

1. Prior to commencing construction, complete the preconstruction leak survey. Document findings in videos, photographs and in writing.

2. Prior to commencing construction, provide a Contingency Plan for new and old equipment and piping in the event of flooding.

3. The Contractor will be held fully responsible by the Owner for any damage to utilities, equipment, properties, buildings, or structures adjacent to or in the general area of the work, through flooding resulting from any cause relating to the work carried out under this Contract. Make good and repair such damage at own expense.

1.17 PROTECTION AGAINST FLOATION

A. Control groundwater level to prevent damage to any pipe or structure due to water pressure during and after construction and until the completed works are accepted.

1.18 PROTECTION AGAINST FREEZING

A. Furnish necessary equipment and fuel for heating buildings and structures during construction. Maintain a minimum temperature of 13^{O}C in interior areas for mechanical, electrical, masonry, painting and other work susceptible to frost damage.

B. Drain pipelines in trench which may be left exposed in winter. Drain pipelines below concrete slabs or in areas too large to heat practicably.

C. Refer to Divisions 3, 4, 9, 15 and 16 as applicable for detailed cold-weather procedures for cast-in-place concrete, masonry, finishes, mechanical work and electrical work respectively.

HOT WORK NOTICE

FOR OPEN FLAME OR HOT WORK.

THIS NOTICE IS ISSUED SUBJECT TO THE OBSERVATION OF THE RULES SHOWN ON THE REVERSE SIDE.

THE JOB LOCATION HAS BEEN EXAMINED AND FOUND TO BE SAFE. A SUITABLE FIRE EXTINGUISHER HAS BEEN INCLUDED WITH THE HOT WORK EQUIPMENT FOR THIS JOB.

1.	A Workman trained in the use of Fire	Yes	☐
	Extinguishers have been provided.	Not Required	☐
2.	Continued forced air ventilation	Yes	☐
	Has been provided.	Not Required	☐
3.	Continued monitoring and testing	Yes	☐
	Has been provided	Not Required	☐

The use of this equipment was authorized by:

Signed: _____

Supervisor/Foreman

Work Order

No. _____ Date _____

Time Started _____ a.m. _____ p.m.

Time Finished _____ a.m. _____ p.m.

Location of Job _____

Welder: _____

Signature

WARNING

THE USE OF THIS WELDING AND CUTTING EQUIPMENT OUTSIDE OF THE AUTHORIZED LOCATION REQUIRES ANOTHER NOTICE.

RULES:

1. Remove combustible materials within 9 metres or cover with fire resistant materials.

2. Immediately before the commencement of work, a competent person shall determine the contents of tanks, piping systems, containers, etc. by testing the atmosphere for:

a.	combustibility	_____ %	
b.	oxygen deficiency	Yes _____	No _____
c.	toxicity	Yes _____	No _____
d.	continuous forced air ventilation is required	Yes _____	No _____
e.	continuous testing for a. b. c. is required	Yes _____	No _____

Tested by: _____

Signature

3. The results of such tests must be recorded in compliance with the occupational Health and Safety Act and regulations that apply.

4. Should tests indicate a contaminated atmosphere, then no hot work shall commence until the atmosphere has been rendered safe by a competent person.

5. Warn persons working at lower level before starting. If necessary, evacuate area.

6. After the hot work has been completed, the work location shall again be checked for fire hazards and shall not be vacated until no fire danger exists.

7. Do not weld or cut over wooden floors unless they are covered with fire resistant material.

END OF SECTION

PART 1. GENERAL

1.1 PRE-CONSTRUCTION MEETING

A. Following award of the Contract and the instruction to commence the work, the Consultant will convene a Pre-Construction Meeting with the Owner's representative, the Consultant and the Contractor.

B. The meeting agenda will include:

1. The designation of official representatives of participants in the work.
2. Requirements for temporary facilities, site signs, offices, storage sheds, utilities, hoarding, site access and use.
3. Site security.
4. Contractor's work schedule, indicating clearly the proposed order and time allowance for various phases of the work in sufficient detail to show weekly progress including the products delivery schedule.
5. A listing of Subcontractors and Suppliers that the Contractor wishes to utilize for completing work on the Contract in accordance with Section 107-3 "Assignment, Subletting and Renting" in the General Conditions. Provide a schedule for submission of Shop Drawings, samples and similar documents.
6. A schedule for site meetings.
7. A review of administrative procedures, including Change Notices, Change Directives, Change Orders, Site Instructions, Record Drawings, Maintenance Manuals, Take-Over Procedures and Progress Claims.
8. The appointment of inspection and testing agencies or firms.
9. Other items as they arise at the meeting.

C. The Consultant will arrange facilities for the meeting, document the responsibilities and necessary activities of the participants during construction as discussed, and prepare and distribute minutes of the meeting to each attendee.

1.2 SITE MEETINGS

A. Conduct site meetings at the project site.

B. Site meeting frequency shall be bi-weekly at no additional cost to the Contract if performance and schedule are not to the satisfaction of the Owner and Consultant. Otherwise, site meetings shall be on a monthly basis.

C. The Owner, Consultant and Contractor will be in attendance. The purpose of these meetings is to discuss the progress of the work and related matters including:

1. Review and acceptance of previous meeting minutes.
2. Field observations and any problems or conflicts.
3. Any problem that may impede work progress and the construction schedule and corrective measures required.
4. Revisions to the construction schedule and the products delivery schedule.
5. Review of submittal schedules.

1.3 CONTRACTOR'S REPRESENTATIVE AT PROJECT MEETINGS

A. The Contractor shall attend Progress and Co-ordination Meetings as directed by the Consultant.

B. The Contractor's representative at these meetings shall be site Supervisor or Project Manager/Engineer and/or a competent and reliable person who is familiar with the work. The Contractor's representative shall have full authority to make decisions on the Contractor's behalf.

1.4 CONTINGENCY ALLOWANCE AND CASH ALLOWANCE

A. A Contingency Allowance is allowed in the Form of Tender to cover extra work approved by the Owner. Some, all, or none of the allowance may be used; Contractor shall have no claim on the allowance not used.

B. The Contingency Allowance includes Unit Prices and a Lump Sum. The basis for payment of the Unit Price items and the costing of the Unit Price items are stated in the Form of Tender.

C. A cash allowance is allowed in the Form of Tender to cover known purchases of equipment, and services. The following services and supplies are anticipated to be purchases within the allowance:

1. Independent inspections.
2. Commissioning, testing, necessary and schedule process shutdowns.
3. Utility company fees for connection of new services.

1.5 FEES AND CHARGES

A. Pay fees and charges imposed for disposal of waste materials.

B. Pay engineering fees for review of substitutions and similar items.

1.6 CONTRACT DRAWINGS

A. The Contract Drawings are divided into Civil, Process, Structural, Mechanical, Instrumentation and Control, Electrical and Standard Sections. Read the Drawings as a whole as details applicable on one Section may appear on the Drawings of another Section.

B. The Contract Drawings provide general routing of piping and general location of equipment unless specific dimensions are indicated. Locate piping and equipment to avoid interference with walkways, other equipment and required headroom.

END OF SECTION

PART 1. GENERAL

1.1 WORK INCLUDED

A. This Section includes the submission of the following data:

1. Schedules for Construction, Shop Drawing Submittal, Product Delivery and Sample Submittal.
2. Insert and Sleeve Location Drawings.
3. Shop Drawing for Permanent Works.
4. Samples.
5. Record Drawings.
6. Site Progress Records.
7. Progress Photographs.
8. Equipment Operating and Maintenance Instruction Manuals.
9. Mock-Ups.
10. Shop Drawings for any Temporary Works.
11. Tender Breakdown.
12. Operation and Maintenance Manual.

1.2 SUBMITTALS

A. Unless otherwise noted, make submittals to the Consultant for review.

B. Make submittals with reasonable promptness and in an orderly sequence to avoid any delay in the work. Failure to submit in ample time is not considered cause for an extension of Contract Time, and no claim for extension by reason of such default will be allowed.

C. For submittals, facsimile transmissions will not be acceptable.

D. Do not proceed with work affected by submittals until review is complete.

E. Review submittals prior to submission to the Consultant. This review represents that the necessary requirements have been verified, checked and coordinated with the Contract Documents. Stamp, sign, date and identify all submissions. The Contractor's responsibility for errors and omissions for providing the specified products and for the construction of the work in accordance with the Contract Documents is not relieved or diminished in any way by the Consultant's review of submittals.

1.3 CONSTRUCTION AND SUBMITTALS SCHEDULES

A. Submit five (5) copies of the proposed construction schedule in accordance with the requirements of the Special Provisions and the City's General Conditions. Update schedules as required.

B. Submit with the Construction Schedule, five (5) copies of each of the following schedule:

1. Shop Drawing submittal schedule.

2. Product delivery schedule.

3. Sample submittal schedule.

C. Construction Schedule shall be computerized bar chart type schedules as specified hereinafter.

D. Prepare the Construction Schedule as specified below. The schedule requirement herein is the minimum required. The Contractor may prepare a more sophisticated schedule if such will aid him in the execution and timely completion of the work.

1. Computerized bar chart type schedule showing work logic sequences, restraints, delivery windows, Shop Drawing submittal and review times, Contract Time, and milestones and shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.

2. Base schedule on standard 5-day, 40-hour work week. With provisions to show both Base and adjusted schedules as required.

3. The bar chart schedule, on maximum 11-inch by 17-inch size paper, must indicate the Critical Path of the work and include the following, as a minimum:

    a. Identification and listing in chronological order of those activities reasonably required to complete the work, including, but not limited to: move-in and other preliminary activities; all Subcontractor work; major equipment design, fabrication, factory testing and delivery dates; equipment system testing and start-up activities; project closeout, cleanup, and site restoration; and specified work sequences, constraints and milestones, including Substantial Completion date(s).

b. Identify: (i) horizontal time frame by year, month, and week, (ii) duration, early-start, and completion for each activity and sub-activity, and (iii) critical activities and project float.

c. Sub-schedules shall further define critical portions of the work.

d. Activity duration for submittals review shall not be less than the review time specified unless clearly indicated and prior written acceptance has been obtained from the Consultant.

E. In addition to other requirements of the Contract, submit the following with each monthly Application for Payment:

1. A revised Construction Schedule or confirm validity of current schedule to reflect: (i) progress of work to within five (5) working days prior to submission; (ii) changes in work scope and activities modified since the previous submission; (iii) delays in submittals or resubmittals, deliveries, or work; (iv) adjusted or modified sequences of work; (v) other identifiable changes; and (vi) revised projections of progress and completion.

2. Submit with the Construction Schedule, Contractor's certification that the progress schedule is the actual schedule being utilized for execution of the work and certification by all Subcontractors with 5 percent or more of the work that they concur with the Contractor's progress schedule submission.

3. A cash flow diagram showing by month the actual work performed to date and the predicted progress to the end of the project. The amounts will be the total including HST and will include contingency funds as expenditures of them become known.

F. If the Contractor fails to complete an activity by its latest scheduled completion date and this failure may extend Contract Time (or Milestones), the Contractor shall, within seven (7) days of such failure, submit a written statement as to how he intends to correct non-performance and return to the original current progress schedule.

G. The Owner may order the Contractor to increase their plant, equipment, labour force or working hours if the Contractor fails to: (i) complete a critical scheduled activity by its latest Milestone complete date, or (ii) satisfactorily execute work as necessary to prevent delay to the overall completion of the project at no additional cost to the Owner.

1.4 INSERT AND SLEEVE LOCATION DRAWINGS

A. Submit insert and sleeve Location Drawings showing the location and size of sleeves, anchor bolts, openings and miscellaneous items to be formed in the work.

1.5 SHOP DRAWINGS (EXCEPT FOR TEMPORARY WORKS)

A. Drawings required to be submitted include but are not limited to:

1. Catalogue Drawings include reprints of Catalogue Drawings of proprietary articles of standard fabrication and Manufacture for the work.

2. Shop Drawings include Dimensioned Line Drawings and related Specifications, information and literature for custom fabricated articles and equipment.

3. Method of construction and attachment or anchorage, erection diagrams and connections. Where products attach or connect to other products, indicate such items have been coordinated, regardless of the Section under which the various products have been specified. Identify by cross references to Design Drawings and Specifications.

B. Submit one (1) digital copy of Shop Drawings and Catalogue Drawings for review. One (1) stamped digital copy will be returned to the Contractor after review.

C. Submit all Drawings in SI metric units.

D. Submit Shop Drawings well in advance of the time when the material is required for use. Coordinate Shop Drawing's prepared by different trades so that information is available to allow proper review and sufficient review time where the work of one trade interfaces with or affects the work of another. Recognize extensive engineering review time required for certain complex equipment or systems.

E. Clearly identify each submission as to the Project Description, Contract Number, Specification Section, Paragraph Number, Equipment Schedule Number, if applicable, and Component.

F. The Consultant will review the Shop Drawings and Product Data Sheets and will indicate the review status by stamping Shop Drawing and Product Data Sheets copies as follows:

1. "Reviewed" or Reviewed as Noted" – If the Consultant's review of a Shop Drawing or Product Data Sheet is final, the Consultant will stamp the Shop Drawing or Product Data Sheet "Reviewed" or "Reviewed as Noted" (appropriately marked) and keep the required number of copies. One (1) digital copy will be returned to the Contractor.

2. "Revise and Resubmit" – If the Consultant's review of a Shop Drawing or Product Data Sheet is not final, the Consultant will stamp the Shop Drawing or Product Data Sheet "Revise and Resubmit", mark the submission with comments, keep one record copy and return two (2) marked prints to the Contractor. Revise the Shop Drawing or Product Data Sheet in accordance with the Consultant's notations and resubmit.

G. The Shop Drawing and the Product Data Sheet reviews do not authorize changes in cost or time. Changes involving cost or time are authorized only by a signed change order.

H. It is understood that the following is to be read in conjunction with the wording on the Consultant's Shop Drawing review stamp applied to each and every Data Sheet or Drawing submitted:

1. "This review by the Consultant is for the sole purpose of ascertaining general conformance with the Contract design concept. This review does not mean that the Consultant approves the detail design inherent in the Shop Drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the Shop Drawings or of its responsibility for meeting all requirements of the Contract Documents.
Be responsible for confirming and correlating dimensions at the place of the work, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades".

I. Identify changes on re-submissions and include revision dates.

J. Material and equipment delivered to the site of the works will not be paid for until pertinent Shop Drawings have been reviewed and accepted.

K. If the Consultant requests details or items on Shop Drawings which the Contractor believes require extra payment or contract time, make any claims promptly and receive acceptance of extra work, before proceeding with fabrication.

L. The Consultant will review the Shop Drawings or Contractor's design only for conformance with the Contract Document design concept and general arrangement. The Consultant's review does not relieve the Contractor from compliance with requirements of the Contract Documents nor relieve him from errors in the Shop Drawings or Contractor's design.

M. Where work is to be designed by the Contractor comply with applicable codes and submit Shop Drawings signed and sealed by a Licensed Professional Engineer.

N. Submit three (3) digital sets of the final Shop Drawings in CD format.

1.6 SAMPLES

A. Submit samples of materials to be used in the work for review in accordance with the requirements of the City of Greater Sudbury General Conditions and Special Provisions.

B. Do not use material in the work which is in any way inferior to the samples submitted and reviewed. Match accepted samples.

C. Review of samples notwithstanding, materials that are unsound or imperfect when delivered to site will be rejected.

D. Identify samples by project name and number, date, name of Contractor and all other pertinent information.

E. Retain reviewed samples on site readily available to the Consultant.

F. In so far as practical, test materials and equipment on site. Where shop test is necessary, give two (2) weeks' notice in writing of shop test date.

G. Provide test reports for each test performed as specified in Section 01800 – Cleanup, Start-up, Commissioning and Training. Submit the reports for inclusion in the Installation, Operation and Maintenance Manual.

H. Submit, in duplicate unless otherwise noted, samples as specified in Specification Sections. Label samples as to origin and intended use in the work.

I. Deliver samples prepaid to the Consultant's business address or testing company as directed.

J. Notify the Consultant in writing, at the time of submission, of any deviations in samples from requirements of the Contract Documents and state the reason for such deviations.

K. Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of work, state such in writing to the Consultant prior to proceeding with the work.

L. Make changes in samples which the Consultant may require, consistent with the Contract Documents.

M. Where changes or modifications of the products for which samples are submitted are required, re-submit samples embodying the required changes or modifications.

N. Where colour, pattern or texture is a criterion, submit a full range of samples.

O. Reviewed samples will become the standard of workmanship and material against which they performed work will be verified and accepted.

1.7 RECORD DRAWINGS

A. The Owner will supply a set of Contract Drawings. Mark thereon all revisions as the job progresses to produce a set of Record Drawings.

B. Note changes made during construction by any of Contractor's forces or those of their Subcontractors.

C. Dimension locations of buried or concealed work, especially piping and conduit, with reference to exposed structures.

D. Completion certificate will not be issued until Record Drawings are complete and submitted.

E. Update these Drawings and make available for monthly review. Drawings not maintained up to date will be considered as stipulated deductions for the purposes of progress payment certificate.

F. Submit Record Drawings for electrical schematic and instrument control diagrams. Submit Operation and Maintenance Instruction Manuals with updated control diagrams, revised to show construction revisions.

G. Submit Record Drawings in SI metric units.

H. Record on the white prints on a daily basis, work constructed differently than shown on the Contract Documents. Record all changes in the work caused by site conditions, or originated by the Owner, the Consultant, the Contractor, or a Subcontractor and by addenda, Supplemental Drawings, site instructions, supplementary instructions, change orders, correspondence, and directions of regulatory authorities. Accurately record the location of concealed mechanical services and electrical main feeders, junction boxes and pullboxes. Do not conceal critical work until its location has been recorded.

I. Do not use these Drawings for daily working purposes and make the set available for periodic inspection by the Consultant.

J. Make records in a neat and legibly printed manner with a non-smudging medium.

K. Dimension the installed locations of concealed service lines on the site or within the structure by reference from the centre line of the service to structure column lines or other main finished faces or other structural points easily identified and located in the finished work.

L. Submit all marked up Drawings to the Consultant at the conclusion of the Contract.

1.8 SITE PROGRESS RECORDS

A. Maintain at the site a permanent written record of progress of the work. Make the record available to the Consultant upon request and provide a copy if requested. Include in the record for each day:

1. The weather conditions with maximum and minimum temperatures.

2. The conditions encountered during excavation.

3. The commencement and the completion dates of the work of each trade in each area of the Contract.

4. The erection and removal dates of formwork in each area of the Contract.

5. The dates, the quantities, and the particulars of each concrete pour.

6. The dates, the quantities, and the particulars of roofing installation.

7. The dates on which major items of equipment are installed.

8. The numbers and classifications of the Contractor's and the Subcontractor's trades people working at the site and the numbers and classifications of construction machinery and equipment and the number of hours each is operated.

9. The visits to the site by the Owner, the Consultant, the regulatory authorities, the testing companies, the Subcontractors and the Suppliers.

1.9 PRE-CONSTRUCTION AND PROGRESS PHOTOGRAPHS

B. Provide pre-construction photographs in digital format prior to commencement of work on the site. Deliver to the Owner/Consultant before starting any construction two electronic copies on CD-ROM or DVD-ROM. The Owner/Engineer may direct the Contractor to obtain additional photographic records of structures and features within the site limits. The pre-construction records will be compared to the post-construction records to assess damage or displacement of existing structures.

A. Obtain pre-construction photos of the existing:

1. Access roads, parking areas, drainage ditches, and additional areas that will be affected by the site works.

2. Existing building(s) at construction sites.

3. Existing watermain where modifications are planned.

B. On commencement of work and at monthly intervals, thereafter, provide two (2) copies of six (6) different view photographs to illustrate the progress of the work. Photographs are to be taken by a professional photographer from locations selected by the Consultant.

C. Photographs are to be in digital format. Photographs must be legibly identified on the back with project name, date and location of exposure.

D. Submit progress photographs with monthly application for payment.

1.10 OPERATION AND MAINTENANCE MANUAL

A. Submit one (1) digital copy of the “Draft” table of contents of the Operation and Maintenance Manuals for each item of equipment after approval of Shop Drawings for review and approval by the Consultant.

B. Submit one (1) digital copy of the “Draft” Operation and Maintenance Manuals for each item of equipment after approval of the table of contents for review and approval by the Consultant.

A. Submit three (3) sets of the “Final” Operation and Maintenance Manuals for each item of equipment a minimum of eight (8) weeks prior to the scheduled start-up of the equipment or the application for a certificate of substantial performance, whichever occurs first.

B. Contractor is required to coordinate binder naming convention, labeling, organization and structure with the Consultant and City’s Plants Maintenance Manager.

C. Submit three (3) copies of electronic Operation and Maintenance Manuals in a CD Format. The CDs shall be indexed by trade (i.e., Mechanical, Electrical and Instrumentation, and General). Each of the trades shall be indexed by equipment and specification number. The electronic format shall be in Adobe Acrobat form. The manuals shall contain all of the information referenced in Section C (Items 1-25) with all shop and field test reports scanned into the individual equipment items. Electronic Operation and Maintenance Manual information will be submitted so that the Owner can access, save and paste relevant information directly into its Computerized Operation and Maintenance Manual System.

D. Each manual is to contain operational information on equipment, cleaning and lubrication schedules, maintenance data, overhaul and adjustment schedules parts list and similar maintenance information. Instructions are to be in simple language so as to guide the Owner in the proper operation and maintenance of the equipment.

E. In addition to information specified above or in other Divisions of the Specification, include the following in each binder:

1. A title sheet shall have the City’s logo affixed and labelled "NAME OF THE PROJECT” followed by “MAINTENANCE MANUAL" and four (4) int/ext photos. Specific layout to be coordinated with the City.

2. A "Table of Contents" page.

3. Binder Edging indicating City’s logo, naming convention, label and Volume 1 of xx.

4. The names and addresses of the Subcontractors, and the Contractor's name and address.

5. A complete list of the names, addresses and telephone numbers of firms and suppliers from whom parts may be purchased and who can affect repair or maintenance on equipment.

6. Copies of the hardware schedule and room finish schedule.

7. Copies of approvals, certificates, and similar documents from governing authorities.

8. A final, reviewed copy of all Shop Drawings and Product Data Sheets.

9. A complete list of instructions and names of Products to be used for the cleaning of and the maintaining of finished building surfaces.

10. Complete explanation of operation principles and sequences.

11. City's "Add Equipment Forms" including complete parts list with numbers, Manufacturer and contact information. Contract is required to coordinate Add Equipment Forms with the Consultant and the City.

12. Instructions for installation, adjustment and operation, lubrication and maintenance of each item of equipment.

13. Equipment, valve and hardware schedules.

14. Recommended spare parts lists.

15. Lubricants list with the designated application and where they may be purchased. Use lubricants, if possible, from a Company whose products are already being used by the Owner.

16. Manufacturer's representative signed reports.

17. Equipment reports for rotating equipment.

18. Safety Data Sheets.

19. Shop and field test certificates and reports.

20. Balancing reports.

21. Written warranties and guarantees.

22. Recommended maintenance practice and precautions.

23. Shop Drawings revised to show construction revisions, one set to be reproducible. Bind in appropriate section in each volume.

24. Wiring loop connection and Control Drawings revised to show construction revisions, one set to be reproducible.

25. Name and telephone number of both factory and local Manufacturer's representative.

F. Catalogue and bind information for each item and equipment in order or Specification Sections. Include:

1. An overall table of contents in front of each binder. Indicate in the table of contents each binder volume.

2. Provide divider and tab for each item listed in the table of contents.

3. Use separate binders for each manual set and for mechanical, electrical and instrumentation equipment. Indicate the General Contractor and Subcontractor in each volume.

G. Do not overfill binders.

H. Provide binder quality to Consultant's acceptance. Binder features:

1. ACCO Binder P5436E.

2. Spine label showing project name, volume number.

3. Dividers with rip-proof, three-hole punched strip, typed tab label, numbered to correspond to table of contents.

4. Store Drawings folded into individual pockets.

I. Do not install or operate any equipment before Manufacturer's instructions have been submitted.

J. Where specifications require installation in accordance with Manufacturer's instructions:

1. Submit three (3) copies of such instructions.

2. Submit instructions in a written form.

K. If, during the Consultant's review of the manuals, revisions are required, the manuals will be returned with details of the revisions required. Revise the manuals accordingly and resubmit them for further review.

L. Submit the final Operating and Maintenance Manuals to the Consultant **prior to the application for a Certificate of Substantial Performance as noted in Section 1.10 above**.

M. The submission of the "Equipment Operating and Maintenance Instruction Manual" **is a condition precedent to the commissioning of the facility and certification of substantial performance**.

1.11 ADD EQUIPMENT INVENTORY SPREADSHEET

A. Submit three (3) copies of the City's "ADD EQUIPMENT FORMS" for each item of equipment a minimum of eight (8) weeks prior to the scheduled start-up of the equipment or the application for a certificate of substantial performance, whichever occurs first. The Contractor will be required to complete all relevant fields for each item provided within the equipment inventory file as a prerequisite to commissioning and a component of substantial completion. The Excel spreadsheet is provided with notes to direct the Contractor in completion of the spreadsheet.

1.12 PREVENTATIVE MAINTENANCE TASK SPREADSHEET

A. The Contractor will be required to complete all relevant fields for each item provided in the add equipment inventory Excel spreadsheet. The Contractor will transfer all Manufacturer's recommended preventative maintenance tasks and frequencies into the spreadsheet. The electronic file is provided with notes to direct the Contractor in completing the above information.

B. The electronic files will be reviewed and 'marked-up' in a similar fashion as the hard copy Operations and Maintenance Manual.

1.13 MOCK-UPS

A. Prepare mock-ups for the work designated in the Contract Documents. Include for the work of all Sections in which mock-ups are specified.

B. Construct mock-ups in locations acceptable to the Consultant or in locations designated in the Contract Documents.

C. Prepare mock-ups for the Consultant's review with reasonable promptness and in an orderly sequence to avoid any delay in the work.

D. If requested, the Consultant will assist in preparing a schedule fixing the dates for preparation.

E. Reviewed and accepted mock-ups will become the standards of workmanship and material against which performance of the work will be verified and accepted. Remove from the site when they have served their purpose, all mock-ups that are not a permanent part of the work.

1.14 SHOP DRAWINGS FOR TEMPORARY WORKS

A. Submit for review Shop Drawings of temporary works which:

1. Control the dimensions and locations of any part of the structures to be constructed under the Contract.

2. Impose loads on parts of the works which are still under construction or on existing structures.

B. Have the work designed by a Professional Engineer licensed in the Province of Ontario. Show the Engineer's seal and signature on the Shop Drawings.

C. Submit one (1) copy of Shop Drawings for review. Payment will not be made for work started or completed without the required drawing review. Submit Shop Drawings well in advance of the time when they are required for construction. Coordinate Shop Drawings prepared by different trades so that information is available to prevent conflict or errors where the work of one trade affects the work of another.

D. One (1) digital copy will be returned to the Contractor after review.

E. Shop Drawings will be reviewed for conformity with the required arrangement and dimensions of the permanent structures and for general conformity with the Specifications.

F. If re-submittal is requested, discuss the comments made and resolve all issues raised by them, and then resubmit the Shop Drawings amended accordingly.

G. Do not begin construction of temporary works until after the completion of review of the Shop Drawings.

H. Review of the Contractor's Drawings does not relieve the Contractor of the responsibility for the results arising from errors or omissions of design or from the use or abuse of the temporary works.

I. Keep one copy of each stamped, reviewed Drawings at the site of the work for reference during the time the construction work is in progress.

J. Make no change in Drawings after they have been reviewed.

K. Submit Shop Drawings in SI metric units.

1.15 TENDER BREAKDOWN

A. The Tender Breakdown provided in the Form of Tender will be used for progress payment draws. The Consultant may, at their discretion, require a further detailed breakdown for payment purposes.

1.16 PROFESSIONAL ENGINEER

A. Where specifications required Professional Engineer Design, such Engineer is required to be licensed in the related discipline in the Province of Ontario, unless otherwise accepted by the Consultant in writing.

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. Comply with the requirements of the General Conditions, Supplementary General Conditions and the Special Provisions.

1.2 CONSTRUCTION SAFETY MEASURES

A. Contractor shall submit a site specific Health and Safety Plan within five (5) working days after the date of Notice to Proceed or prior to mobilization on site, whichever occurs first. The site specific Health and Safety Plan must address the requirements of the Acts.

B. The Contractor shall meet the requirements of the following:

1. Occupational Health and Safety Act, Regulations for Construction Projects, O.Reg. 213/91 (as amended by O.Reg. 631/94), Part II General Construction.

2. Occupational Health and Safety Act, Industrial Establishments Regulation, R.R.O. 1990, Regulation 851 (as amended by O.Reg. 516/92, 630/94, 230/95 and 450/97), Part I Safety Requirements.

3. Revised Statutes of Ontario 1980, Chapter 321, Revised Regulation of Ontario 1980, Regulation 691 as amended by O.Reg. 156/84, O.Reg. 645/86 and O.Reg. 714/82.

4. Workers Safety & Insurance Board (WSIB) and municipal statutes and authorities.

C. In event of conflict between any provisions of above authorities, the most stringent provision governs.

D. Where applicable, the Contractor shall be designated “Constructor” as defined by Ontario Act.

1.3 SPECIAL PROTECTION AND PRECAUTIONS

A. Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handing, storage and disposal of hazardous materials and regarding labeling and the provision of Safety Data Sheets (SDS) acceptable to Labour Canada.

B. Conform to the Ministry of Labour requirements for work in hazardous locations. Establish and implement written procedures to assure compliance.

C. Comply with the Owner's Health and Safety Procedures. An Owner's staff member will provide one hour of orientation to a specified representative of the Contractor. The Contractor is responsible for providing training to all of their staff on-site.

D. Smoking is not permitted in hazardous areas or other areas as designated by the Owner. Post "No Smoking" signs as required.

1.4 SAFETY EQUIPMENT AND HAZARDOUS AREAS AND MATERIALS

A. Safety equipment such as gas detection equipment for explosive or toxic gases or oxygen deficiency, safety belts, ropes, etc., are to be made available to the resident inspection staff. When it is required for the resident inspection staff to enter manholes or other potentially hazardous areas, a Contractor's personnel has to enter the said areas with him and accompanying personnel with safety ropes, etc., shall be present as required.

B. Post warning signs at hazardous areas or where hazardous materials are stored and install protective barriers. Instruct personnel in proper safety procedures.

C. Identify all areas considered to be hazardous locations and comply with all requirements of the Ministry of Labour.

D. Comply with the requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labeling and provision of Safety Data Sheets acceptable to Labour Canada.

E. The Contractor shall inform the Owner of the location of these materials and shall ensure that these materials are not kept stored or used on site without the City's prior consent or approval.

F. Note that certain gas lines passing through the work area will continue in service during this construction. Take suitable safety precautions at all times.

1.5 SITE CONDITIONS

A. Work at the site may involve contact with:

1. Diesel Fuel.
2. Confined Spaces.
3. Heavy Equipment.
4. Unstable Soils, Trenches and Stockpiles of Material.
5. Hot and Cold Weather Conditions.

1.6 WORK IN HAZARDOUS AREAS AND CONFINED SPACES

A. Test for explosive, toxic gases, oxygen deficiency before commencing the day's work and while working in areas which may contain an explosive, toxic or oxygen deficient atmosphere. If a hazardous condition is found, make the work area safe before commencing or continuing work.

B. Use non-sparking tools in areas where an explosive atmosphere may exist.

C. Hazardous Locations in Existing Structures:

1. The following areas in or near existing structures for the purpose of this Contract is considered Class I Division 1 Group C and D Hazardous Locations:

   a. Sanitary Sewer Lift Station.

   b. Manholes and diversion structures.

D. Work Procedures for Hazardous Locations/Confined Spaces:

1. Conform to Ministry of Labour requirements for work in hazardous locations. Establish and implement written procedures to assure compliance.

2. Construction activities, except wire pulling and cleaning, that occur in hazardous locations require continuous combustible gas monitoring, by the Contractor.

3. Provide documentation of tests for gas and oxygen deficiency prior to starting work in hazardous locations.

4. Ensure that all personnel engaged in confined space work or work in hazardous locations that require the use of respiratory equipment, comply with the requirements of the Ministry of Labour and must be clean shaven.

5. It is the Contractor's responsibility to provide all necessary gas detector equipment, ventilation, other safety devices required by law.

6. Smoking is not permitted in hazardous areas or other areas as designated by the Owner. Post "No Smoking" signs as required.

E. Metering for Toxic Gas, Combustible Gas, Oxygen Deficiency:

1. Monitor toxic gas, combustible gas, and oxygen deficiency at all levels in hazardous locations as per requirements of Ontario Occupational Health and Safety Act.

F. Meter Operator:

1. Have a competent person trained to operate and read the portable meter continuously while construction activities occur in the designated hazardous locations. All levels of hazardous location are to be monitored. This Meter Operator is not permitted to assist in the construction activity in any way. Locate Meter Operator in the immediate vicinity of construction activity. If work in two or more different hazardous locations is required at the same time, provide additional meter operators and meters.

G. Hazardous Event Procedure:

1. If the meter indicates 5% of the Lower Explosive Limit (LEL) or 19.5% oxygen, discontinue construction activity, evacuate area, and notify Engineer.

H. Log Book:

1. Maintain a log book with:

a. Date.

b. Name of Meter Operator.

c. Explosive gas, toxic gas, and oxygen deficiency readings at all levels every ½ hour.

d. Construction activity type.

e. Location of construction activity.

2. Submit log book to the Owner when construction is complete.

3. Firefighting equipment.

4. Provide and maintain suitable firefighting equipment when working in the designated hazardous locations. Train Contractor's personnel working in these areas in the use of firefighting equipment.

1.7 WHMIS

A. The Contractor shall provide a complete list of all controlled products, hazardous materials, products containing hazardous materials, and all biological or chemical agents or devices or equipment producing or emitting a physical agent and any substance, compound, product or physical agent that is deemed to be or contains a designated substance as defined under the Act and the Regulations, which will be or may be used for the work, prior to the commencement of the work. The Contractor shall provide appropriate information and Safety Data Sheets, where required, for the substances used in the performance of the work.

B. Where hazardous materials, biological or chemical agents and/or designated substances are used in the performance of the work, the Contractor shall ensure that the requirements of the Act and the Regulations are complied with, including any requirement to train workers, provide appropriate labels and Safety Data Sheets or to implement a Control Program.

C. The Contractor shall take steps to inform the Owner of the location of these materials and to ensure that these materials are not kept stored or used at a location where an employee of the Owner could be working with or exposed to the substance, without the Owner's prior consent or approval.

D. Comply with the requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials, and regarding labeling and provision of Safety Data Sheets acceptable to Labour Canada.

1.8 SAFETY EQUIPMENT

A. Provide safety equipment such as ropes, safety harness, combustible/hazardous gas and oxygen depletion meter for the use of the resident inspection staff. Provide competent staff to resident inspection staff when entry is required to manholes or other areas which may be hazardous. Resident services staff are not allowed to enter such areas alone.

1.9 INDOCTRINATION

A. The City of Greater Sudbury requires that all Contractors working on City property be indoctrinated in accordance with the requirements of the Contract.

B. Develop a site specific indoctrination procedure.

C. The site specific indoctrination shall contain the following basic components:

1. Site specific training of workplace hazards, designated materials and work conditions.

2. Site specific training of safe work procedures, required safety equipment, and sign-in/sign-out requirements.

3. Location of all safety equipment, sanitary facilities, and rest areas.

4. Training on requirements of the Environmental Controls Plans and Emergency Response Plan.

5. Suitable record system for documenting training, record of personnel trained, and record of companies trained.

6. Any other components as deemed necessary for compliance with applicable laws and statues, or as directed by the Engineer.

D. Ensure all personnel performing work or visiting the site have received site specific indoctrination, or are accompanied by a competent Supervisor:

1. Provide all trained staff with a certificate of attendance at the site specific indoctrination.

2. Provide all visitors with an appropriate tag and safety equipment as deemed necessary.

END OF SECTION

PART 1. GENERAL

1.1 TESTING AND QUALITY CONTROL

A. Furnish to the Consultant, when requested and consistent with progress of the work, test results and mix designs specified in the Contract Documents or required by by-laws, statutes and regulations relating to the work and the preservation of public health, including the following:

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

2. Testing, adjusting and balancing of air ducts and other conveying systems, mechanical and electrical equipment and systems.

3. Mill tests and certificates of compliance.

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

B. The costs of all specified testing of piping systems, tanks, etc. shall be included in the cost of the Contract per Section 105-2 “Source and Supply and Quality of Materials” in the General Conditions.

C. In addition to the above items, arrange and pay for the following:

1. Inspection and testing required by law, ordinances, rules, regulations or orders of public authorities.

2. Inspection and testing performed exclusively for the Contractor's convenience, or testing performed for items or parts designed and built by the Contractor.

3. Testing, adjustment and balancing of mechanical and electrical equipment and systems.

4. Vibration monitoring per Section 02030.

5. Tests specified to be carried out by the Contractor under the supervision of the Engineer.

D. Quality control inspections, other than those noted above to be paid by the Contractor, will be carried out by inspectors or inspection services under the direction of the Engineer on behalf of the Owner, and at the Owner’s cost. The Contractor shall provide clear access to work areas to be inspected and assist as required by providing safety equipment, ladders, material, etc., for these inspections including but not limited to, welding X-ray inspection, concrete testing, painting inspections and compaction tests.

E. The Owner may provide the services of an independent inspection company to perform the following routine quality control services, without cost to the Contractor. The Owner's tests do not relieve the Contractor of their own quality control:

1. Compaction of backfill and granular base courses.
2. Concrete cylinder testing, aggregate testing and cement testing for both cast-in-pace concrete and precast concrete items.
3. Welding X-ray inspection and painting inspections.
4. Torque of high-strength bolts.
5. Load tests of structural items.
6. Subgrade examination for loading bearing capability if required.

F. The Contractor shall make known to the Consultant the source of imported material at least one week prior to the time he proposes to use such material, unless otherwise specified in the Contract.

G. The Owner may request samples. Cooperate with the field inspection staff. Provide concrete and other materials for tests. Provide labour as necessary to assist in the handling of samples.

H. Provide proper facilities for the storage of concrete specimens at correct temperature, free from vibration or damage in accordance with the instruction of the inspection and testing agent and the governing standard. Provide six minimum/maximum and three concrete thermometers for the exclusive use of the resident inspection staff. Provide boxes for storing and curing and crates for transporting concrete cylinders.

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

J. Remove and replace products indicated in inspection and test reports as failing to comply with the Contract Documents at no additional cost to the Owner.

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

L. Pay the costs for the re-inspection and testing of replaced work.

M. Additional testing required to prove the adequacy of construction shall be at the Contractor's expense, where the routine test shows the construction to be inadequate or where the Contractor's materials and procedures have not been as specified or when work has proceeded without approval or inspection.

N. Where the work or product is specified to be designed, inspected, tested and certified by the Contractors:

1. Such additional testing or retesting will be performed by a testing agency approved by the Owner.

2. Notify the Consultant and the appropriate inspection and testing agent not less than 48 hours before the commencement of the part of the work to be inspected and tested.

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

4. Ensure the inspection and testing reports are issued promptly (normally within 48 hours), and that the Consultant is notified forthwith if the report indicates improper conditions or procedures.

5. Co-operate with and provide facilities for the Owner's inspection and testing agents to perform their duties.

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

    a. Date of issue.

    b. Contract name and number.

    c. Name and address of inspection and testing company.

    d. Name and signature of inspector or tester.

    e. Date of inspection or test.

    f. Identification of the Product and Specification Section covering inspected or tested work.

    g. Location of the inspection or the location from which the tested product was derived.

    h. Type of the inspection or test.

    i. Remarks and observations on compliance with the Contract Documents.

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

1.2 SURVEY LINES AND LEVELS

A. The field staff of the Consultant will supply information to establish co-ordinates and basic benchmark. The Contractor shall verify correctness of stakes and marks and perform survey and layout work:

1. The layout of new structures is based on the connections and relationships with the existing structures. Dimensions shown require verification and adjustment as the existing structures are exposed.

2. Expose the existing structures. Confirm existing dimensions both above and below grade.

3. Provide accurate measurements to the Consultant. Co-ordinate with the dimensions shown and propose the final dimensions to be used for the layout.

4. Await the Consultant's review and complete the layout to the reviewed dimensions.

5. Establish required lines, elevations and grades. Erect and protect batterboards, site lines and reference boards, during excavation and construction of structures.

6. Establish points from which floor and wall surfaces in each room can be determined and maintain the same for co-ordinating the work of various trades.

7. Carefully protect all benchmarks and reference points.

B. The Consultant’s field staff will from time to time verify lines, elevations, grades, reference marks and batterboards.

C. Correct errors in lines, elevations, grades, reference marks and batterboards disclosed by the verification of the resident field staff of the Engineer.

D. Make the work available for checking as required by the resident field staff of the Consultant.

1.3 ELEVATIONS

A. Unless otherwise stated, elevations given on the Drawings or in the Specifications refer to the datum of the Geodetic Survey of Canada expressed in SI metric units.

B. Benchmarks will be indicated on site plan and established on site as required.

C. Verify elevations given, promptly report discrepancies to the Consultant in writing.

1.4 SURVEY MONUMENTS

A. Maintain survey monuments, iron bars, round iron pipes and stakes for marking property boundaries and locations.

B. Where monuments, pipes or stakes are located on the line of the trench or within the limits of the work the Owner will replace them.

C. Do not remove survey monuments without receiving prior approval. Pay for or replace monuments, which are removed without approval.

1.5 LAYOUT OF THE WORK

A. Where several systems and products are concentrated in an area, and before installation, pre-plan the total installation by preparing minimum 1:50 scale reproducible interference drawings detailing the location and identifying each system and product. Submit the Drawings to the Consultant for review as for Shop Drawings.

B. Install systems and products so as to provide the maximum headroom, clearances for access, specified floor to ceiling heights, and to minimize offsets in pipes, conduit, ducts and structural framing.

C. Run pipes, ducts, tubing and conduit plumb or level (except where specific slope is required for proper function) and parallel with building surfaces.

D. Unless indicated or specified otherwise install pipes, and ducts, tubing and conduit so they will be concealed above ceilings, behind furring and in walls as required to conform to finished room dimensions, except in mechanical and electrical equipment rooms or similar spaces.

E. Notify the Consultant and request clarification if locations of fixtures, fittings, equipment and services to these items interfere with interior finishes and use of the work.

1.6 CODES AND STANDARDS

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

B. Unless the edition number and date are specified, the reference to the Manufacturers and Published Codes, Standards, and Specifications are to the latest edition published by the issuing authority, current at the date of bidding.

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

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

E. Where reference is made to regulatory authorities, it includes all authorities that have, within their constituted powers, the right to enforce the laws of the place of work.

F. All construction work shall comply with the Ontario Construction Codes.

G. All mechanical piping system work, including equipment, must comply in all respects with requirements of the Ontario Technical Standards and Safety Authority, and CSA Standards B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, fittings, valves, equipment, etc., must bear a CRN number.

H. All electrical items associated with mechanical equipment are to be CSA (or equivalent agency) certified (electrically) or bear a stamp to indicate special Ontario Hydro Approval.

1.7 FASTENERS, ANCHORS, BRACES AND SUPPORTS

A. Provide the fasteners, anchors, braces and supports required to maintain installations attached to the structure or to finished floors, walls and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.

B. Use fasteners compatible with the structural requirements, finishes and types of products to be connected. Do not mix products subject to electrolytic action or corrosion where conditions are liable to cause such action.

C. Where hangers are suspended from concrete slabs, install inserts before concrete is placed using inserts designed for the specific purpose.

D. Use anchors appropriate to the load requirements where installation of ducts, pipes or other installations render built-in inserts inaccessible. Locate anchors to avoid damage to reinforcing bars.

E. Verify that the fasteners, anchors, braces and supports for suspended installations, and the structure to which they are to be secured are designed to support the load requirements, including safety factor.

F. Where a fastener installation is suspect, have on-site tests of installed fasteners, performed by an independent testing laboratory acceptable to the Engineer, using properly engineered and calibrated force-measuring meters.

G. Where the floor, wall or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure that is to support the products.

H. Provide reinforcing or connecting supports, where required, to distribute the loads on the structural components.

I. Do not use wood plugs or hammer-impact fasteners. Anchoring to floor topping fills is not acceptable. Secure the anchors in floors to the floor structure.

J. Where a performance requirement is specified, submit engineering calculations and written verification signed by a Registered Professional Engineer that the installation has been inspected and is structurally sound and in accordance with design requirements.

K. Fastenings which cause spalling or cracking of the structure or products to which anchorage is made are not acceptable.

L. Space the anchors within limits of load bearing or shear capacity and ensure they provide positive permanent anchorage.

1.8 CUTTING AND PATCHING

A. Remove and replace defective and non-conforming work.

B. Where new work connects with existing work and where existing work is altered, cut, patch and make good to match existing work.

C. Do cutting with power saws or core drilling equipment. Use only handheld pneumatic or impact tools for breakout. Make all cuts with clean, true and smooth edges.

D. Do not cut, bore, or sleeve any load bearing structure without the written consent of the Consultant. Submit details with each request for consent.

E. Make connections watertight.

F. Provide openings in non-structural elements of the work for penetrations of mechanical and electrical work. Co-ordinate size and location of such openings with the trade involved.

G. Fit construction tightly to ducts, pipes, conduits and similar products to stop air movement completely. Where such work penetrates a fire separation element or wall of the building, pack the penetration around the duct, pipe, conduit or similar for the length of the openings with ULC listed fire stopping packing product as part of the work specified in Divisions 15 and 16.

H. Prepare the surfaces to receive patching and finishing.

I. Refinish the surfaces to match the adjacent finishes. For continuous surfaces refinish to the nearest intersection, and for an assembly, refinish the entire unit.

1.9 LABOUR, PRODUCTS AND WORKMANSHIP

A. Products named in the Specifications or on the Drawings by Manufacturer's name and model number establish the size, quality and performance standards for the work. In most cases, alternate Manufacturer's products are listed as acceptable for the named Manufacturer's product. Base the bid price on the named, Manufacturer's product or the product of a named alternate Manufacturer. If no alternate Manufacturers are listed, base the bid price on the named, Manufacturer's product.

B. The work has been designed on the basis of the named, Manufacturer's product. The bid price shall not be based on any alternate, non-named, Manufacturer's product. The Form of Tender contains an Alternate Form for placing the name and cost savings for any product or equipment which the Contractor would wish to use as an alternate to the named product of equipment in the Specification or on the Drawings.

C. Should the Contractor wish to use an alternate product, he is to ensure that the alternate, acceptable, Manufacturer's product is equivalent in size, quality and performance to the named Manufacturer's product. Include on the Alternate Form for any modifications to the work necessary to accommodate the alternate, acceptable, Manufacturer's product and submit for the Consultant's review a dimensioned layout of the space into which such product is to be installed.

1.10 EVIDENCE OF CONFORMING TO STANDARD

A. Where materials are specified to conform to a standard – for example, reinforcing steel, G30.12 M Grade 400 – provide mill reports, invoices or other statements, which certify that materials are in fact to the specified standard.

B. Where the Contractor proposes to use materials not manufactured to a standard, provide test reports, which show that the proposed material meets the requirements of the specified standard.

1.11 CERTIFICATION OF WORKS

A. Before issuing the Certificate of Substantial Performance, the following documentation shall be provided to the Contract Administrator. All labour, materials and equipment required to complete the work shall be included in the unit prices for the items requiring such works.

1. Watermain Certification:

    a. A Bedding Gradation Analysis must be provided to show that the bedding conforms to the minimum gradation requirements defined in Table 2A of GSSS 1010.

    b. Bedding compaction results are not required to form part of the certification package.

2. Sanitary/Storm Sewer and Subdrain Certification:

    a. A Bedding Gradation Analysis must be provided to show that the bedding conforms to the minimum gradation requirements defined in Table 2A of GSSS 1010.

3. Close-Circuit Television (CCTV) Camera Inspection:

    a. Results of the CCTV camera inspection must indicate that the sanitary and/or storm sewer and/or subdrain was placed on the proper alignment without damage, sags or debris.

    b. CCTV camera inspections requirements (of sewer mains and lateral) are to follow:

        1. All digital data are to be coded following the WRc Manual of Sewer Condition Classification, WRc 4th edition, American Society of Civil Engineers or a comparable manual.

        2. All videos are to be coded utilizing WRc codes and provided in .wmv format along with the database.mdb (or other approved .mxd) files.

        3. All photos are to be provided in .jpg and reports in .pdf.

    c. All digital image recordings shall be of quality that all minor defects (hairline cracks, etc.) are clearly visible, and in the main sewers, the colour of the pipe inspected be true to the actual conditions.

    d. Video files shall commence with a minimum 10 second data information screen including: date and time of inspection, location description, Contractor and Operator name.

    e. Technicians assigned to data gathering shall have a minimum of three (3) years related experience in sewer inspection, using Closed Circuit Television Equipment and Data Collection and shall be capable of report all conditions using WRc defect codes.

4. Pressure Leakage Tests:

    a. Results of the Exfiltration test on all sanitary sewers or Infiltration test on all sanitary sewers and storm sewers installed below the groundwater table must indicate that the main has been adequately sealed as per the procedure and requirements outlined in OPSS 410.

5. Roads/Curbs Certification:

    a. Base Material – Granular “B”:

        1. A gradation analysis must be provided to show that the Granular “B” conforms to the minimum gradation requirements defined in Table 2A of GSSS 1010.

        2. Results of compaction testing must indicate that the Granular “B” material has been compacted according to the requirements set out in GSSS 501 and Method A of OPSS 501.

        3. Compaction testing must be performed at 15 meter intervals along the roadway in a 3-point cross section for each lift of material and all test results must be supplied to the City.

        4. Please note that the material specified with the City approved Construction Drawings must be used. If an alternate type of Granular ‘B’ material is to be contemplated, this must be done as part of the Construction Drawing review process.

    b. Base Material – Granular “A”:

        1. A gradation analysis must be provided to show that the Granular “A” conforms to the minimum gradation requirements defined in Table 2A of GSSS 1010.

        2. Results of compaction testing must indicate that the Granular “A” material has been compacted according to the requirements set out in GSSS 501 and Method A of OPSS 501.

        3. Compaction testing must be performed at 15 metre intervals along the roadway in a 3-point cross-section and all test results must be supplied to the City.

    c. Asphalt Works:

        1. Analysis of the asphalt material must be provided to show that this material conforms to the minimum requirements defined in OPSS 1150 and the Supplier’s mix design approved by the City.

2. Results of the compaction testing must indicate that the asphalt material has been compacted according to the requirements set out in GSSS 310 and OPSS 310.

3. Compaction testing must be performed at 15 meter intervals along the roadway in a 3-point cross-section for each lift of material and all test results must be supplied to the City.

d. Concrete Works:

1. Slump, Air and Compressive Strength of Concrete:

a. For concrete curb and gutter systems, concrete testing must indicate that the concrete used meets the minimum requirements set out in OPSS 353.

b. For sidewalk installations, concrete testing must indicate that the concrete used meets the minimum requirements set out in OPSS 351.

c. For any other concrete works, materials, construction, and testing must comply with the relevant GSSS, OPSS, GSSD, OPSD, and any additional requirements set forth on the City approved Construction Drawings.

d. The submitted compressive strength test results must meet the requirements set out within the relevant GSSS and OPSS (for example, if 28 day test results are the standard, the submitted results must meet this requirement).

e. Surface Features:

1. All surface features that form part of the City approved Construction Drawings must be constructed before initial acceptance. This includes all fencing, noise berms, and drainage ditching (excluding rear yard swales), etc.

END OF SECTION

PART 1. GENERAL

1.1 ACCESS TO THE SITE

A. Provide construction entrances to the site and assure normal operation of the wastewater system is maintained.

B. Under no circumstances shall the private driveways and other areas be used for any construction activity or construction related vehicular parking or delivery.

C. Inspect the existing access drives roads, walkways and culverts to be used for construction and provide all necessary material and labour to upgrade existing to be suitable for the construction activities. Remove temporary access facilities and restore to its original condition.

D. Provide and maintain temporary service roads, walkways and culverts to ensure safe, convenient and adequate access, and as required for construction of the works including work related to demolition activity, site clearing, excavating and backfilling.

E. No access via any other entrance except as mentioned above will be allowed. The Contractor is responsible to maintain a log documenting the date, name, company, entry times, and exit times of all people passing through the access gate who are related to the construction activities encompassed in these works.

F. The area for sitting the Contractor's trailer and parking to be approved by Consultant.

G. The existing entrances and exits will need to remain clear and accessible at all times.

H. The Contractor will be responsible for maintaining the cleanliness of the roads from the entrance to the Contractor's work area.

I. Neighboring and adjacent site shall be maintained in good condition at all times.

J. Signage used by the Contractor shall be constructed as part of this Contract in sufficient detail to direct all traffic relating to this Contract to the Contractor's work area. Construction traffic will not be permitted to access the site via other locations.

K. The Contractor will be responsible for maintaining access for the Owner's operations and maintenance personnel at all times during construction. Normal operation and maintenance for the existing facility may require extensive occupation and duration by both Owner and the Operations Contractor and any current or future Subcontractors retained by the Owner for normal operation and maintenance requirements. The Owner will make all efforts to notify the Contractor of ongoing maintenance and operations activities. However, the Owner will make no warranty regarding the accuracy of quantity and duration of maintenance and operational activities.

L. Where not indicated on Contract Drawings, the Contractor shall maintain vehicular and pedestrian access to all access doors, chambers, maintenance holes within the site. When requested by the Owner, provide unabated access to each access point for required duration.

1.2 TEMPORARY BUILDINGS

A. Provide temporary buildings and hygienic facilities which meet the requirements of Ontario Regulation 659/79.

B. Maintain all temporary buildings clean and free from nuisances so as to avoid danger to plant property or structures prevent complaints from plant personnel and prohibit interferences with the operation of the existing plant.

1.3 SITE WORKING AREAS

A. Site working areas are as indicated on Contract Drawings.

1.4 SECURITY

A. Provide lockable truck gates. Maintain the enclosure in good repair.

B. Provide and maintain security and surveillance in order to provide a measure of security as well as safety, against injury to persons not concerned with construction. The Owner does not assume liability for breaches of security on the jobsite.

1.5 TEMPORARY UTILITIES

A. The Contractor is responsible for making his own arrangements for telephone access on the site.

B. Potable water from designated outlets may be used and metered. Provide hoses as required including proper installation and certification of any required backflow prevention systems. Repair any damage caused during use of existing water outlets.

C. Existing electrical power may be used and metered. Replace any blown fuses or damaged breakers and repair any damage caused. Provide extension cords as required. Do not overload circuits beyond their rated capacities.

D. The Contractor shall reimburse the Owner for all metered utilities at the completion of the Contract.

E. Provide ground fault protection for all electrical equipment.

F. Temporary electrical wiring on this Project shall meet the requirements of the "Temporary Wiring Standard" dated May 1, 1973, published by the Construction Safety Association. For the purpose of the Temporary Wiring Standard, the Contractor is designated the "Constructor".

1.6 TEMPORARY LIGHTING

A. The existing lighting systems may be used at no cost to the extent possible during construction. Provide additional lighting as required. When work is complete, clean all fixtures and lamps that have become soiled by the performance of the work.

B. Provide all temporary electrical lighting to provide uniform, well-lit work areas at all times.

C. Secure all temporary lighting and wiring from damage. Falling or tripping hazard.

1.7 EQUIPMENT

A. The Contractor shall provide at his own expense all manner of materials, labour, scaffolding, ladders, hand tools and appliances necessary for the due execution and proper completion of the work described herein, unless otherwise specified in the tender specifications. Equipment will not be loaned by Owner.

1.8 CONTRACTOR, SUBCONTRACTORS AND CONSULTANT'S SITE OFFICE

A. Provide and maintain temporary portable site office if required. Subcontractors may provide their own site offices as necessary. Locate site offices where directed by the Owner and the Consultant.

1.9 SITE STORAGE SPACE

A. Provide and maintain outside storage. Locate storage facilities where directed by the Consultant. Provide enclosed storage space for the storage of products that cannot be stored in the open unprotected.

B. Do not schedule delivery of products that require protective storage on the site until suitable site storage space is available.

C. Remove from the site products that have been damaged by reason of improper storage or otherwise and replace with new products.

D. Store products on site in accordance with the Manufacturer's instructions.

1.10 SANITATION FACILITIES

A. Do not use existing plant washroom facilities. Provide temporary sanitary facilities in accordance with the Occupational Health and Safety Act.

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. All conditions of the Contract apply to the work of this Section.

1.2 INTENT

A. This Section includes mandatory construction sequencing constraints and a suggested sequence of construction that will satisfy the mandatory constraints required in the prosecution of the work.

B. The suggested sequence of construction described herein is general in nature and illustrates the design intent with respect to prosecution of the work. Prepare and submit a proposed sequence of construction for review by the Owner and Engineer. This review will serve to satisfy the Owner and Engineer that all mandatory construction sequencing constraints have been properly addressed by the Contractor in the proposed sequence of construction but shall in no way absolve the Contractor of complete responsibility for prosecution of the work in accordance with the requirements of the Contract Documents.

C. The suggested sequence of construction described herein outlines the intent of the design with respect to keeping the existing sewage pumping running at all times during construction. The descriptions of construction activities as outlined in this Section are not intended to be comprehensive or all-inclusive. Many other construction activities and work components, although not specifically noted in this Section, are integral parts of the work and shall be scheduled and completed by the Contractor in accordance with the Contract Documents.

D. The broad grouping of parts of the work under phases, stages or similar divisions in the suggested sequence of construction is intended to illustrate general sequence for prosecution of the work as envisioned by the Engineer. Such grouping shall in no way absolve the Contractor of complete responsibility for construction means, methods, techniques, sequences and procedures of construction, or the safety precautions and programs incidental thereto.

1.3 SUBMITTALS

A. Submit proposed sequence of construction in accordance with Section 01330.

1.4 SERVICES PROVIDED BY CONTRACTOR

A. Provide all required temporary piping, valves and appurtenances, including all other requirements necessary to bypass the sewage pumping station when necessary and approved, and clean wells when necessary to prosecute the work in a safe manner as specified. Commissioning in accordance with Section 01800 must be completed for the bypass system.

B. Provide all necessary temporary power, pumping facilities, lighting, ventilation facilities and temporary bulkhead systems as required during construction and work in the station wet well and dry well.

1.5 SUGGESTED SEQUENCE OF CONSTRUCTION

A. The suggested sequence of construction described herein is based on the Engineer's knowledge of the design components of the project and not on experience in the construction of such work. The Engineer assumes no responsibility for the time required to construct the work following the suggested sequence of construction.

B. The Contractor may on his own initiative submit an alternate proposed sequence of construction to the Engineer for review. Such review shall in no way make the Engineer responsible for the time or costs required to construct the work following the Contractor's alternate sequence of construction.

C. Incorporate the construction constraints and sequence of construction in the Progress Schedules required in Section 01330.

D. The suggested sequence of construction describes in general the sequence of installation and commissioning of major structures, processes, and equipment items. Be responsible for determining which ancillary services, such as electrical, instrumentation, plumbing, drainage, heating and ventilation are also required to be completed to permit commissioning of the structures, processes and equipment as described.

E. Carefully examine the existing utility services at the site to determine the difficulty of the work and the number and type of pipelines and cables required to be re-routed or protected from damage during construction of the work.

F. Prior to making major tie-ins to existing process units and structures, demonstrate that the equipment installed in all new structures is fully functional. Connections to existing works will not be permitted until all equipment in the new adjacent works operates to the satisfaction of the Engineer. No claim for delay will be entertained due to unsatisfactory operation of any equipment.

1.6 MONITORING AND EMERGENCY RESPONSE

A. Have the necessary resources, materials, personnel, and equipment readily available to provide continuous 24 hours per day, seven (7) days per week monitoring and emergency repair of sheeting, shoring, bypassed pumping station wet well and other such temporary systems where, in the opinion of the Owner or the Engineer, the failure of such temporary systems could adversely impact plant operations.

B. Provide and operate temporary systems as required to contain and remove leakage through gates, valves and other such isolation devices that are used to accommodate scheduled construction activities.

PART 2. PRODUCTS

2.1 GENERAL

A. Unless specifically stated otherwise, provide all labour, materials, and equipment necessary to accomplish the work of this Section.

PART 3. EXECUTION

3.1 CONSTRAINTS

A. Contract working limits for this Contract are shown on the Drawings.

B. Lift Station (pumps, valves, and other works inside pumping wells):

1. The Contractor shall carry out the work in the existing wet wells in the shortest time period possible and when the lift station is bypassed. The necessity of sewage handling all times during construction period will require a temporary bypass pumping be provided for current pump shutdowns, however the specific operating conditions and high flows may not allow the wet well(s) to be shut down on specific days of the construction period. As well as scheduled shut down may be cancelled due to such reasons. The Owner will not pay any extra and accept delays due to such a condition should a shutdown not proceed or be postponed.

2. The Contractor is required to work within the space constraints shown and to the time and existing plant operation constraints. The Contractor's schedule of work shall identify these constraints and any critical path scheduling concerns.

3.2 SUGGESTED SEQUENCE OF CONSTRUCTION

A. The suggested sequence of construction is as follows:

1. Site Mobilization: Construction fencing, site access, temporary utilities, obtain permits, pre-construction surveys, etc.

2. Excavation: Grading, layout, etc.

3. Site Works: Including construction of new walkway as shown on the Site Plan.

4. Temporary Power, Pumping:

    a. The Contractor shall comply with all safety requirements for working in the raw sewage pumping wells and shall have emergency plans in place prior to proceed with the work in the wells.

    b. Prior to start removals of major equipment such as current gen-set, pumps and electrical panels that may impact sewage pumping continuity:

        i. Provide temporary pumping along with independent permanent and standby power for the period of from existing lift station shutdown to when new pumping equipment commissioned and operational.

        ii. Temporary sewage pumping system shall be adequately sized and be capable of handling of a combined flow of 67 L/s @ 28 m TDH with a 60 mm solid passage on continuous pumping basis. Two (2) pumps 1 duty, 1 standby are required for the temporary bypass application.

        iii. Excavate forcemain location near lift station and install forcemain isolating buried valve along with a temporary or permanent DI tee fitting upstream of this. This connection may be used for temporary sewage pumping into forcemain.

        iv. Extend excavation with shoring to include new valve chamber and yard piping areas and to the depth required for pipe bedding, removals as well as adequate depth for replacement materials under valve chamber with non-frost granular.

        v. Temporary pump suction shall be from lift station upstream maintenance hole to allow complete isolation of lift station, while conveying sewage flows.

        vi. Contractor to monitor upstream maintenance hole sewage level all times to ensure no surcharge or back-up occurs during temporary pumping period. Contractor shall provide automated pumping system including pump level controls, and alarm systems tie-ed into City's SCADA system.

c. A separate dewatering pumping system shall be provided for ground/storm water handling during excavations and construction works.

d. Complete startup, testing, and commissioning of the temporary pumping system prior to removal of existing equipment.

5. Initial Removals:

a. Inspect and assess safety issues prior to enter and/or start working in the wells.

b. All pumps in the dry well shall be shut down and locked-off.

c. Complete removals inside of dry and wet wells.

d. Main power to electrical panels to be disconnected and locked-off.

e. Complete removal of existing electrical and gen-set along with existing building enclosure.

f. Remove lower concrete slab inside wet well of the lift station as well as concrete benching removals. Protect the wells from up flow lifting as required.

g. The Contractor shall proceed with all possible upgrade and repair works required inside the existing wet wells.

6. Upgrades and Installations:

a. Complete structural works including modifications to the ground level floor slab and installation of new access platform at wet well lower.

b. Fill with concrete and seal existing pump suction pipes in wet well and complete benching and other structural requirements.

c. Complete Process, mechanical, electrical and control installations and upgrades, including new raw sewage pumps.

d. Install yard piping and cabling.

e. Install new electrical gen-set.

f. Install new MCC in building and complete wiring and controls.

g. Upgrades to electrical power system and new transformer to be installed and completed.

h. Commissioning of upgraded lift station.

7. Further Removals:

    a. Inspect and assess safety issues prior to enter and/or start working in the wells.

    b. Remove existing pumps and equipment in the dry pit.

    c. Complete cutting and removal of existing dry pit.

    d. Fill with concrete and seal existing piping allowed to leave in-ground.

8. Other Works:

    a. Complete other uncompleted works as required.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. The General requirements listed herein shall be supplemental to the Special Provisions and General Conditions of the City of Greater Sudbury and are related to the construction of the Don Lita Lift Station Upgrades.

1.2 FIRST NAMED AND ACCEPTABLE NAMED ALTERNATIVES

A. The Tender shall be based only on products, materials and equipment specified or listed in the Contract Documents.

B. Where more than one trade or Supplier's name is given, the Contractor shall note that the design, as shown on the Drawing, has been based on the first name listed. In the event that acceptable alternative material is used, the material and equipment supplied must be equal in quality, material and performance (including maximum and minimum criteria specified or implied) to the material/equipment first named in the Specification. Any design and/or construction changes necessitated by the use of other named trade or Supplier's names given are the sole responsibility of the Contractor and shall be at the expense of the Contractor. The Contractor shall be responsible for coordinating these additional requirements assuring the proper fit and matching of all equipment and materials.

1.3 NON-NAMED ALTERNATIVE EQUIPMENT

A. Where the Contractor proposes to use a non-named alternative major piece of equipment, the Contractor is to comply with the requirements set in the Instructions to Tenderers.

B. After the acceptance of a tender, the Contractor may apply to the Owner/Consultant to review a non-named product or minor piece of equipment for approval as a substitution for the specified product. The cost for this review will be paid for by the Contractor regardless of whether the proposed substitution is accepted or rejected. In all cases, the proposed substitution must be justified by the Contractor in their written application to the Owner/Consultant indicating reasons why they wish to substitute (significant delay in delivery, strikes, unavailability, improved quality or field service, etc.) and be accompanied by sufficient descriptive and technical information of the Owner/Consultant to thoroughly compare articles or group of articles with that specified. Failure to comply with this requirement to the Owner's/Consultant's satisfaction may result in rejection of the request due to insufficient information or time to evaluate same. All applications and submissions related to substitution shall only be

made by the Contractor and not by any Subcontractors or Suppliers. Those submitted by the Subcontractors or Suppliers will not be given consideration.

C. The approval or rejection of a proposed substitution shall be at the discretion of the Owner/Consultant and his decision shall be final.

D. The Contractor shall assume all responsibility for liabilities and additional costs that may subsequently arise as a result of his proposed substitution being accepted by the Owner/Consultant.

E. The Contractor assumes and accepts responsibility for all liabilities, additional cost and additional design work required as a result of acceptance of the proposed substitution.

F. No ruling on a proposed substitution will be made prior to acceptance of a tender. No substitution shall be made without the prior approval of the Owner/Consultant. No Tender Price shall be based on a presumed acceptance by the Owner/Consultant of any proposed alternate equipment.

END OF SECTION

PART 1. GENERAL

1.1 INTENT

A. This Section contains requirements for the Contractor in carrying out and documenting testing work and training of Operations staff, as required under this Contract.
In addition, this Section contains requirements for the Contractor during compliance, operational and performance testing for all mechanical, electrical, instrumentation and controls equipment and systems provided under this Contract. This Section also contains site clean-up (progressive and final) requirements of the Contractor under this Contract.

B. This Section applies to both temporary bypass systems required for constructing the works, and permanent installations as a requirement of Substantial Performance.

C. This Section supplements but does not supersede testing requirements found elsewhere in the Specifications.

D. This Specification shall be applied to all Divisions in the Tender Document.

1.2 PROGRESS CLEANING

A. Maintain the work in tidy condition, free from accumulation of waste products and debris, other than that caused by the Owner.

B. Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

C. Remove waste material and debris from the site at the end of each working day.

D. Clean interior areas prior to start of finish work, maintain areas free of dust and other contaminants during finishing operations.

1.3 FINAL CLEANING

A. In addition to the progressive removal of rubbish from buildings, structures and site, and leaving the buildings broom clean, perform the following work before acceptance and prior to applying for a Certificate of Substantial Performance of the work:

1. Remove waste products and debris other than that caused by the Owner and leave the work clean and suitable for occupancy by the Owner.

2. Remove surplus products, tools, construction machinery and equipment. Remove waste products and debris generated or caused by the construction activities.

3. Clean hardware.

4. Remove paint spots and smears from all surfaces.

5. Vacuum clean all building interiors affected in construction operations.

6. Make a thorough inspection of all finishes, fixtures, and equipment to make sure of proper workmanship operation.

7. Vacuum inside and outside of all new, control panels, prior to turning over the facility to the Owner.

8. Repair any damage to existing roadway, fencing, etc., due to construction activities.

B. Remove all temporary work from the site including but not limited to fencing, sign board, samples and any other items not considered to be part of the permanent works.

C. After successful completion of leakage tests, clean debris and foreign matter from the structures.

1.4 START-UP AND COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. Definitions:

1. Start-Up (or Compliance Testing): A test or tests in the presence of the Consultant and the Owner to demonstrate that the installed equipment or system meets Manufacturer's installation and adjustment requirements and other requirements specified including, but not limited to, noise, vibration, alignment, speed, proper electrical, instrumentation and control, mechanical connections, thrust restraint, proper rotation, initial servicing and instrumentation calibration.

2. Commissioning (Operational and Performance Testing): A test performed in the presence of the Consultant and the Owner and after any required start-up specified, to demonstrate and confirm that the equipment and/or system meets the specified operational performance requirements, while simulating actual operating conditions to the greatest extent possible.

3. System: The overall process, or a portion thereof, that performs a specific function. A system may consist of two or more subsystems as well as two or more types of equipment. Examples of systems on this Contract are as follows:

   a. Process Mechanical and Electrical Equipment.

   b. Instrumentation and Controls.

B. Submittals:

1. Submit five (5) copies of the proposed start-up and commissioning schedules and Work Plan for equipment units and systems four (4) weeks prior to start of related testing for approval by the Consultant. Revise schedule based on Consultant's review and resubmit five (5) copies of the approved schedule.

2. Include in the start-up and commissioning schedule the following items as a minimum:

   a. A list of all equipment to be tested.

   b. Tests which will be performed for each related piece of equipment.

   c. Test plan.

   d. Test procedure.

   e. Plan for calibration of instruments.

   f. Time and date for each test in daily stages.

   g. List of Subcontractors and Equipment Suppliers which will be present for each test.

C. Testing Preparation:

1. General:

   a. Complete work associated with the unit and related processes before testing, including related Manufacturer's representative installation inspection services.

   b. Provide related Operating and Maintenance Manuals, complete City's required "ADD EQUIPMENT FORMS" and provide spare parts and special tools as specified before testing any unit or system.

   c. Document start-up and commissioning procedures and when necessary Contingency Plans.

   d. Designate and provide one or more persons to be responsible for coordinating and expediting Contractor's facility start-up duties. The person or persons shall be present during facility start-up period. The Consultant will also designate a person to interface with the Contractor's facility start up person. Coordinate all start up activities with the Consultant's designate. The Owner will also designate a person(s) to interface with the Consultant's and Contractor's designates.

e. Coordinate with the Consultant and City staff any Public Service Announcements (PSA) as required. PSA, Sudbury & District Health Unit and the Ministry of the Environment notifications will be managed by the Consultant and the City of Greater Sudbury.

f. Provide services of qualified Manufacturer's representatives to assist in testing.

g. Provide all electrical power, fuel, lubricants, water, temporary piping, temporary instrumentation and labour for testing, start-up and commissioning.

h. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.

2. Cleaning and Checking: Prior to start-up complete the following work. Start-up will not proceed until all cleaning and checking is completed:

a. Calibrate testing equipment for accurate results.

b. Inspect and clean equipment, devices, connected piping, and structures so they are free of foreign material.

c. Provide all oils and grease for pre-purchased equipment. Lubricate all equipment in accordance with Manufacturer's instructions.

d. Turn rotating equipment by hand and check motor-driven equipment for correct rotation.

e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.

f. Check power supply to electric-powered equipment for correct voltage.

g. Adjust clearances and torques.

h. Test piping for leaks.

i. Obtain completion of applicable of Manufacturer’s Certificate of Proper Installation.

3. Ready-to-test determination will be based on full compliance with all of the following:

a. Notification by Contractor of equipment and system readiness for testing.

b. Acceptable testing plan.

c. Acceptable ADD EQUIPMENT FORMS, Operation and Maintenance Manuals incorporating.

d. Review comments.

e. Receipt of Manufacturer's Certificate of Proper Installation, where specified.

f. Adequate completion of work adjacent or, to interfacing with, equipment to be tested.

g. Availability and acceptability of Manufacturer's representative, when specified, to assist in testing of respective equipment.

h. Equipment and electrical tagging complete.

i. All spare parts and special tools delivered to the Owner.

D. Start-Up:

1. Begin testing on time based on approved test schedule.

2. For Start-up Activities in Confined Space locations, provide at least two (2) Contractor's staff who are trained and certified for confined space entry procedures. Provide all necessary confined space entry equipment and conform to the Owner's confined space requirements.

3. Without exception, all equipment shall be checked, witnessed by the Consultant and Owner's staff, and tested for:

   a. For Control Loop Checkout/Verification, arrange for the Contractor, Electrical, Instrumentation and Control Subcontractors for testing of loop wiring between instrument and field devices and advise the Consultant to be present for the procedure.

   b. When testing instrumentation loops, perform the testing of each loop in sequence and in groups. The testing of instrument loops will be graded on a pass/fail basis. If more than two instrument loops within a group fail the loop checkout, the entire group of loops will be deemed to have failed the checkout. When the failed loops have been repaired, the entire group must be retested.

   c. Complete the Owner's/Consultant's Standard Installation/Start-Up Check Out Forms in the Appendix and ensures all parties sign the respective forms. Provide five (5) copies. The forms presented are a minimum and additional forms will be provided as required.

      1. Installation Checklist – Equipment.

      2. Installation Checklist – Piping.

      3. Installation Checklist – Valves.

4. Installation Checklist – Tanks/Vessels.
5. Installation Checklist – Instruments (Various).
6. Installation Checklist – Panel/PLC.
7. Instrumentation Checklist – Termination and Continuity.
8. Installation Checklist – Electrical.
9. Calibration Checklist – Instruments.
10. Test Report – Equipment.
11. Test Report – Piping Pressure.
12. Test Report – Valves.
13. Test Report – Tanks/Vessels.
14. Control Loop Check out/Verification Form.
15. Electrical Equipment Inspection Report.
16. Manufacturer’s Installation Certification.
17. Manufacturer’s Instruction Certification.

d. Provide written documentation of all tests not covered by above forms.

e. Provide the services of a qualified Manufacturer's service representative to assist in the start-up of the equipment.

f. In addition to the test reports specified above, submit the Manufacturer's representative's signed report describing in detail the findings of the start-up inspection, tests and adjustments made, quantitative results and suggestions for precautions to be taken for correct maintenance, if any, and a Manufacturer's certificate stating that the installation of the equipment has been inspected, is installed in accordance with the instructions, has been started and adjusted as necessary and that the equipment is ready for operation and is in warranty condition.

g. Complete all necessary modifications or adjustments to the system based on the start-up. Verify that the equipment and its installation conforms to the requirements of the Contractor the service intended and is ready for permanent operation.

h. When all corrections and adjustments have been made to the equipment, provide the services of the Manufacturer's representative to reverify the modifications and/or adjustments made and certify that the equipment is ready for continuous operation. Submit five (5) copies of the revised check out forms.

i. Submit five (5) copies of the revised check out forms.

j. Submit five (5) copies of the Manufacturer's Certificate that the equipment is ready for Operation and Maintenance Manuals.

k. Equipment will only be accepted after receipt of the Manufacturer's representative is scheduled to perform these services.

l. Modify or replace equipment or materials failing required tests.

m. Perform additional testing required due to failure of materials or construction to meet specifications. Provide additional services of the Manufacturer's representative for inspection and start-up to meet specification.

n. If, in Consultant's opinion, each system meets the start-up requirements specified, such system will be accepted as conforming for purposes of advancing to commissioning phase, if required. If, in Consultant's opinion, start-up results do not meet requirements specified, the systems will be considered as non-conforming.

o. Commissioning shall not commence until the equipment or system meets start-up test requirements specified.

E. Commissioning:

1. General:

a. Begin commissioning after satisfactory completion of all start-up tests.

b. Unless otherwise indicated, provide services specified or required, all labour, materials, and supplies for conducting the test and taking all samples and performance measurements.

c. Prepare commissioning report summarizing test method. Include test logs, pertinent calculations, and certification of performance.

d. Any analytical laboratory work required for commissioning will be performed by the Owner.

e. Conduct commissioning as required to demonstrate system performance.

f. In addition to the general mechanical and electrical commissioning, complete commissioning as specified in each specific equipment section included but not limited to testing specified in Division 11, Division 13 and Division 16.

g. The Owner may conduct independent testing to verify test results. If through the independent testing, the testing fails, the Contractor to correct deficiencies retest and pay for retesting.

2. Construction/Operation Delineation during Commissioning Construction:

   a. Contractor to identify all equipment and/or systems that are being installed with a red tag to indicate that the Contractor is installing and responsible for the equipment.

   b. After the equipment has been installed, aligned, start-up, tested and certified by the Manufacturer/Vendor as having been installed properly, remove the red tag from this equipment and/or system and replace with a green tag only as directed by the Consultant.

   c. All equipment and/or systems identified with a green tag will indicate that the equipment is fully functional and may be used by the Owner for operation of the facility.

3. Operational Testing:

   a. Following the demonstration of all systems and subsystems as specified above under Start-Up or Compliance Testing, the Contractor is required to operate the equipment for a test period not exceeding five (5) days but not less than two (2) days, or as directed and determined by the Consultant at normal operating levels with water. If the demonstration is not successful, reschedule for another test period under the direction of the Consultant. Obtain all necessary permits from the applicable regulating bodies to allow for the temporary withdrawal and discharge of water if this demonstration procedure requires withdrawal and discharge of water.

   b. Instruct the Owner’s staff in the operation and maintenance of designated equipment and instrumentation. Provide the services of a qualified Manufacturer's representative for training of the Owner’s staff. Include for trade specific operation and maintenance instructions. Provide for this training in two sessions on different days. Provide copies of all information presented to operating staff during instruction.

   c. Correct deficiencies revealed during initial operation. Correct and adjust equipment operation.

4. Performance Testing:

    a. Prior to turning over the operating facility to the Owner, place the new, refurbished and reconstructed works in operation starting on a designated Monday. The performance testing shall be undertaken.

    b. For a period of 14 continuous days, the Contractor will operate the meter to demonstrate the proper operation. If everything is not satisfactory after 14 continuous days, continue until the operation of the work is satisfactory or reschedule a new 14 day Start-Up Program.

    c. The Contractor is to have supervisory personnel, mechanics, electricians, instrument technicians and other workmen on site during the normal working day and as required at other times to ensure the safe continuous operation of the facility. During other times, the Contractor is to have the above personnel on call to attend to any adjustments and corrections required.

    d. The Contractor shall install temporary piping, bulkheads and control that may be required during performance testing and shall perform all works necessary to commission the system to render it fully operational.

    e. Performance testing includes operation of equipment using initially simulated interlock and alarm signals where necessary, to check functionality. It also requires completion of loop checks from field instruments by simulated or quantifiable process inputs to the terminals in the Local Control Panel, for interface with the PLC/RPU. These checks may require further calibration of field instruments.

5. Facility Commissioning and Performance Testing:

    a. Pre-requisite for Facility Commissioning and Performance Testing:

        1. Successful completion of start-up, operational testing, performance testing and training as specified herein.

        2. Submission of five (5) copies of the proposed start-up and commissioning schedules and work plan for equipment units, and systems four (4) weeks prior to start of related testing for approval by the Consultant.

    b. Once all equipment and sub-systems have been tested individually and completed to the satisfaction of the Owner and the Consultant, the Contractor shall perform performance testing on the completed Facility as a whole.

    c. A significant interruption will require the test then in progress to be stopped and restarted after corrections are made. Significant interruptions include any of the following events:

1. Failure of the Contractor to maintain qualified on-site personnel as scheduled.

2. Failure of any equipment item or system component to meet specified performance requirements for more than two (2) consecutive hours.

3. Failure of any critical unit, system, or subsystem that is not satisfactorily corrected within six (6) hours after failure.

4. As may be determined by the Owner and Consultant.

d. Acceptance Criteria:

1. The Facility has operated satisfactorily for 14 days, after performance testing of individual sub-systems, at the rated capacity, on a continuous basis.

2. Successful demonstration of all four levels of operation/control, as defined herein.

3. Acceptable system responses to simulated abnormal/emergency conditions, including, but not limited to, localized power failure, specific hardware failure.

e. System commissioning shall be considered complete and successful when, in the opinion of the Owner and Consultant, the process system operates in the manner intended at plant design for the specified period.

f. Should the operation be halted for any reason related to the facilities constructed or the equipment furnished, the system Commissioning Program must be restarted and repeated until the specified continuous period has been accomplished without interruption.

g. Any defects found during the commissioning period must be repaired or the specific part or entire equipment item must be replaced to the complete satisfaction of the Owner and Consultant and at no cost to the Owner. This also applies to pre-purchased equipment.

h. Equipment and process parameters must be archived during system commissioning for the Owner's reference and records.

i. The above procedures shall be satisfactorily completed prior to the facility being considered ready for use as set out in the Construction Lien Act.

j. Correct deficiencies revealed during initial operation. Correct and adjust equipment operation.

1.5 TRAINING

A. Prior to handing over process and control systems, pieces of equipment or devices to the facility for operation and maintenance, the Equipment Supplier is to provide training to Operations and Maintenance staff. The training sessions are to be given specific to the respective operation or maintenance trade, group or staff. Training is not to be initiated prior to the full installation of the process system in each process train, each building, piece of equipment or device and is demonstrated to be functioning in the context of normal operations, without relying on other non-functioning devices or processes.

B. Provide the services of factory representative, who has complete knowledge of proper operation and maintenance of the equipment to instruct representatives of the Owner and Consultant on proper operation and maintenance, including start-up and shut-down procedures, proper lubrication practices and troubleshooting of all equipment.

C. Submit all On-Site Training Program outlines to the Consultant for approval prior to any on-site training. Prepare and distribute 20 copies of handout materials required to ensure an effective Training Program. As a minimum include the following general information and instructions as well as specific trade information in each On-Site Training Program. Each training session shall encompass the following topics as a minimum:

1. Function of the equipment.
2. Theory of the equipment operation.
3. Start-up, shutdown, normal operation, and emergency operating procedures of the equipment.
4. Identify and discuss safety items and procedures.
5. Safety concerns and safe operation of the equipment.
6. Preventative maintenance procedures including lubrication requirements.

D. Provide operator training for each process, electrical, instrumentation and control system and piece of equipment to the Owner's staff.

E. The training is to be conducted in a room at the plant and at the equipment or system.

F. Training is to begin a minimum of seven full working days after the Operating and Maintenance Manuals have been delivered to the Consultant.

G. Training sessions are to be scheduled with the Owner's operating staff and are to continue until all the Owner's staff is completely familiar with all operating and maintenance procedures. Note that sessions will have to be repeated to ensure that staff members performing their normal duties will also be trained.

1.6 SPECIAL TOOLS

A. Supply with each piece of equipment all special tools and accessories required for repair and adjustment.

B. Turn such tools over to the Owner as specified above.

END OF SECTION

DIVISION 2

SITE WORKS

INDEX

PART 1. GENERAL

1.1 GENERAL

A. The Contractor shall provide all necessary monitoring equipment as indicated in this Specification and any other equipment not listed under this Specification to protect the existing structures and utilities and to monitor ground, existing structures and utilities movement during demolition, excavation, and new construction without any additional cost to the Owner.

1.2 SECTION INCLUDES

A. Labour, products, equipment and services necessary for installation of monitoring instrumentation and equipment work in accordance with the Contract Documents.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Section 01010 – General Instructions.

B. Section 01330 – Submittals.

C. Section 01351 – Health and Safety.

D. Section 01400 – Quality Requirements.

E. Section 02040 – Monitoring Program.

F. Section 02315 – Excavating, Trenching and Backfilling.

G. Section 02140 – Dewatering.

H. Section 02150 – Bracing and Shoring.

1.4 REFERENCES

A. ASTM C144, Specification for Aggregate for Masonry Mortar.

B. Ontario Water Resources Act, MOE Regulation 903.

C. Ontario Regulation 213/91 – Construction Projects under Occupational Health and Safety Act.

D. Ontario Provincial Standard Specification (OPSS) for Temporary Protection System (OPSS.MUNI 539).

1.5 SUBMITTALS

A. Submit Shop Drawings for review in accordance with Section 01330 – Submittals.

B. The Shop Drawing submission shall include, but not be limited to, the following.

1. Shop Drawings for Sequence of Construction.

2. Other submittals as listed in this Specification and for all equipment/products.

C. Submit the following in accordance with the Monitoring Plan:

1. Proposed Monitoring Plan and procedure indicating the location, type and number of instruments.

2. Proposed Manufacturer, product name, type and other pertinent information to fully describe all monitoring equipment (where used).

3. Proposed equipment to be used for drilling and grouting, including Manufacturer and model number of drill rigs, and method to be used for advancing the boreholes and cleaning the inside of casings or augers.

4. Proposed schedule for drilling and grouting.

5. Driller's qualifications, for review and acceptance by the Owner and the Consultant.

6. Proposed equipment to be used for vibration monitoring.

7. Proposed secure web-based digital point of transfer.

8. Details of data transmission including all applicable protocols.

1.6 QUALITY ASSURANCE AND CONTROL

A. Refer to Section 01400 – Quality Requirements.

B. Notify the Owner/Consultant prior to drilling any borehole in ground or installing equipment on existing structures/utilities.

C. Personnel employed for monitoring must have at least four (4) years of direct field experience in construction monitoring using the proposed equipment.

PART 2. PRODUCTS

2.1 MATERIALS

A. Sand: In accordance with ASTM C144.

B. Water: Potable.

C. Bentonite or Polymer Additives: For controlling viscosity of drilling fluids as required.

D. Surface Protection Boxes:

1. Design Surface Protection Boxes to:

a. Withstand repeated vehicle loads.

b. Prevent instrument tampering.

c. Drain freely of surface water.

d. Resist corrosion.

2.2 INSTRUMENTATION

A. Open Standpipe Piezometers (OSP), Observation Wells:

1. For Monitoring Groundwater Levels and include:

a. Open pipe with porous filter (sand) at base of borehole.

b. Annulus seal around riser pipe consisting of grout mix.

c. Vented top cap to riser pipe at collar of hole.

2. Install Water Level Datalogger within Piezometer for continuous measurements:

a. Install barometric datalogger within one standpipe at the site for continuous measurements.

b. Locations and details of these monitoring points are in accordance with Contract Drawings.

B. Surface Monitoring Points (SMP):

1. For Monitoring Vertical and Horizontal Deformation and include:

a. SMP to monitor deformation depending on the structures to be monitored. Details to be provided by the Contractor.

b. Locations and details of these monitoring points are in accordance with Contract Drawings.

C. Utility Monitoring Points (UMP):

1. For monitoring specific underground services for displacement.

2. Locate and seal UMPs into boreholes adjacent to or above service to be monitored.

3. Locations and details of these monitoring points are in accordance with Contract Drawings.

D. Building Monitoring Points (BMP):

1. For Monitoring Vertical Movement and include:

a. 50 mm x 50 mm square self-adhesive reflective targets.

b. Total Station Survey instruments for measurement.

2. The height of BMP targets shall be at least 3 m above the existing grade.

3. Approval from Property Owner required for location and height of BMP targets.

4. Proper adhesive and epoxy treatment may be required for BMPs sticking on structures.

E. Noise Monitoring Points (NMP):

1. List of sound level meters to be used, associated hardware (pre-amplifiers, microphones and sound calibrators).

2. Manufacturer's name, model number and serial number for all components of sound level meter.

3. Submit calibration records and certificates.

4. Minimum Equipment requirements:

a. Type 2, in accordance with IEC 61672-1 or ANSI/ASA S1.4, Integrating Sound Level Meter, including free field microphone with windscreen used to conduct noise monitoring.

b. Monitors contained in outdoor weather protected enclosures:

i. Mounted minimum 3 m above grade.

ii. Direct microphone towards source of construction activity noise concern.

c. Monitor:

i. Able to log, at minimum, Linear and A-Weighted (dBA), Leq, and L90 and L10 statistical values simultaneously in one hour intervals. For other logging requirements refer to Section 02 23 03.

ii. Able to record audio riles associated with noise events (10 s minimum duration), including information on duration of event and Leq for the event.

d. Monitoring Instrumentation:

i. Supply with necessary accessories for remote monitoring access capabilities.

ii. Able to send automated notifications on hourly basis of exceedances of both review and alert levels.

F. Vibration Monitoring Points (VMP):

1. List of vibration monitoring equipment associated hardware, software (for examples, unit, pre-amplifiers, Accelerometers).

2. Manufacturer's name, model number, and serial number for all components of Vibration Monitoring Device.

3. Submit calibration records and certificates, 15 days before monitoring activities for noise monitoring equipment to be used.

4. Minimum Equipment requirements:

a. Capable of measuring tri-axial, in-ground, PPV in mm/s with a frequency range of 1 to 100 Hz.

b. Direct sensor axis towards the source of vibration concern at each location.

c. Monitors that measure building vibration and are located inside a building:

i. Install at the foundation or basement floor at the corner or wall closest to the construction.

ii. Install at level to ensure accurate recording of vibration levels.

d. Monitors that measure building vibration and are located outdoors:

i. Install at ground level, or shallow-buried (150-300 mm deep) in the ground.

ii. Install at level to ensure accurate recording of vibration levels.

e. Capable of remotely send information (as a minimum PPV and time of recording) pertaining to exceedance of the review level.

G. Dataloggers:

1. For monitoring instruments at major instrumentation sections.
2. Location and protect from immediate construction activities.
3. Protect cable connected to central monitoring station from damage.
4. Locations and details of these monitoring points are in accordance with Contract Drawings.

PART 3. EXECUTION

3.1 PREPARATION

A. Prepare specific areas for instrumentation by chipping with pneumatic hammer, cleaning with air water jet or other means acceptable to the Owner/CA. Apply neat cement paste, grout or other materials for final finish, as directed by the CA.

3.2 DRILLING, GROUTING, PREPARATION, ACCESS AND PROTECTION

A. Prepare specific areas for instrumentation by chipping with pneumatic hammer, cleaning with air water jet or other means acceptable to the Owner/CA. Apply neat cement paste, grout or other materials for final finish, as directed by the CA.

B. Drill holes for installation of instruments in concrete, asphalt, cased holes in fills and soil. Drill different holes lengths and diameters in accordance with Contract Drawings.

C. Flush holes with clean water until free of debris. Redrill holes which are unacceptable. Backfill abandoned holes with cement grout to acceptance of the Owner/Consultant.

D. Prior to installing instruments, remove material adhering to inside of casing or augers, and cuttings.

E. When withdrawing drill casing or augers during instrument installation in borehole, minimize length of unsupported borehole and rate of casing or auger withdrawal.

F. Do not permit collapse of boreholes.

G. Withdraw casing or auger without rotation.

H. Casing or Auger may be omitted when:

1. Open borehole does not cause borehole to collapse.

2. This method does not affect instrument installation.

I. Install temporary access (such as stationary or transportable working platforms), if required by the Consultant.

J. Install sufficient general area lighting for installing instruments.

K. During and after installation, be cautious and protect instruments or devices.

L. Install temporary power as required.

M. Replace damaged instruments or devices due to performance of work.

N. Install protection to exposed parts of instruments in accordance with Contract Drawings or as required by the Owner/Consultant.

O. Use equipment capable of thoroughly mixing grout material to maintain consistency.

1. Mixes:

a. Cement Grout: Water, Portland cement and sand, except that 100% of sand passing No. 16 sieve.

b. Cement-Bentonite Grout: 10 kg cement, 1.2 kg bentonite, 24 litres water.

c. Mix to uniform consistency and in accordance with Manufacturer's written instructions.

P. Use tremie method to place grout, where applicable, with side discharge ports on tremie pipe.

3.3 INSTALLATION

A. Field locate positions of instrumentation in accordance with Contract Drawings. Obtain utility clearances. Changes in location are to be reviewed and accepted by the Owner/Consultant prior to installation.

B. Drill and grout boreholes for instrumentation installation.

C. Supply and transport instruments, testing equipment, and accessories to installation locations.

D. Prepare soil and concrete surfaces for instrument installation and testing.

E. Fabricate and install surface boxes and lids for instruments including vibrating wire piezometers, inclinometers, surface monitoring points, utility monitoring points, deep settlement points, borehole extensometers and other applicable instruments installed in boreholes in accordance with Contract Drawings.

F. Sample soil as directed by the Owner/Consultant to confirm that instruments are installed within appropriate soil deposits.

G. Provide and fabricate protection for installed instrumentation. Protect from damage during construction and maintain exposed instrumentation components. Repair or replace instruments damaged by performance of work, to acceptance of the Owner/Consultant. Notify the Owner of damage or maintenance problem.

H. After installation, clean-up and restore area around instrument location to original condition.

I. Provide the following instrumentations and materials (where required):

1. OSP, waterlevel dataloggers, barometer dataloggers and associated readout units.
2. BMP (rod and/or sleeve only).
3. UMP (rod and sleeve only).
4. VMP (Vibration Monitoring Device and accessories).
5. NMP (Noise Monitoring Device and accessories).

J. Install instruments within boreholes, except for convergence gauges and strain gauges in excavation.

K. Maintain and calibrate readout units.

L. Collect, process and report data.

M. Provide, monitor, and interpret data from any additional instrumentation necessary to control its method of operation. Ensure safety of personnel and ensure integrity of Work. Supply data from additional instrumentation in a similar form to that specified in Section 02040 – Monitoring Program. Install and monitor CG and VWSG in excavation as specified and in accordance with Manufacturer's recommendations.

N. Install instruments in accordance with the Owner/Consultant direction.

3.4 INSTALLATION TOLERANCES

A. Surface Position of Boreholes: Based on field conditions and within 1000 mm of specified location.

3.5 DISPOSAL OF INSTRUMENTATION

A. Do not dispose, backfill, remove, or salvage instruments without the prior written consent of the Owner. Instruments are to be used until Substantial Performance.

B. Remove salvageable instruments only when directed by the Owner/Consultant.

C. Salvaged instruments remain the Owner property.

D. Backfill borehole casings for instruments with cement grout up to underside of surface restoration.

E. Backfill surface excavations with unshrinkable fill, when within roadways or sidewalks, and with selected fill when outside of such areas. Fill up to underside of surface restoration. Remove steel casings, if any, to a minimum depth of 1500 mm below ground surface.

F. Prior to completion of work, restore surfaces affected by installation of instruments to their original condition.

G. Fill slope indicator casings, and OSP with Cement-Bentonite Slurry Grout in accordance with MOE Regulation 903 unless otherwise directed by the Owner/Consultant. Decommission piezometers in accordance with MOE Regulation 903.

3.6 INSTALLATION AND INSPECTION – GENERAL

A. The equipment/products shall be installed as indicated on the Contract Drawings and these Specifications, in accordance with the Manufacturer's recommendations and as approved by the Consultant.

B. Provide the services of a factory trained representative(s) to inspect, operate, test, adjust, and troubleshoot the installations.

C. Inspection to include checking for:

1. Cracks and other damaged or defective parts. Each equipment/product, as well as accessories, must be undamaged, without cracks and free of defective parts.

2. Completeness of installation as specified and as recommended by the Manufacturer.

3. Correctness of setting, alignment and relative arrangement of various parts of the system.

D. Provide for additional supervision of installation by Equipment Manufacturer as required. Arrange with the Consultant a mutually agreeable date when the representative should be on site.

E. Complete on-site testing and provide the results of all tests.

F. Submit a report, signed by the Manufacturer's Representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment/products conforms to all Specifications.

3.7 SUPERVISION OF INSTALLATION AND COMMISSIONING – GENERAL

A. Provide commissioning and startup in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. At the completion of satisfactory installation, each unit shall be started by the Contractor under the supervision of the Manufacturer and in conjunction with plant operating conditions.

C. Equipment/products shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's Representative.

D. Modify or replace equipment/products failing required tests.

E. Perform additional testing required due to changes of equipment/products and/or failure of equipment/products or construction to meet Specifications at no extra cost to the Owner.

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. The Contractor shall provide all necessary vibration monitoring equipment as indicated in the Contract Documents and any other equipment not listed under this Specification to protect the existing structures and utilities and to monitor ground, existing structures and utilities movement during demolition work, excavation, and new construction without any additional cost to the Owner.

1.2 SECTION INCLUDES

A. Labour, products, equipment and services necessary for installation of vibration monitoring instrumentation and equipment work in accordance with the Contract Documents.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Section 01010 – General Instructions.

B. Section 01330 – Submittals.

C. Section 01351 – Health and Safety.

D. Section 01400 – Quality Requirements.

E. Section 02020 – Monitoring Instrumentation and Equipment.

F. Section 02040 – Monitoring Program.

1.4 REFERENCES

A. Ontario Provincial Standard Specification (OPSS) for The Use of Explosives (OPSS.MUNI 120).

B. City of Sudbury, Regulating Noise, By-law 2018-29.

1.5 SUBMITTALS

A. Submit Shop Drawings for review in accordance with Section 01330 – Submittals.

B. The Shop Drawing submission shall include, but not be limited to, the following:

1. Shop Drawings for location and details of monitoring points.

2. Other submittals as listed in this Specification and for all equipment/products.

C. The Contractor shall submit details of the Vibration Monitoring Plan to the Owner and the Consultant for review. The submittals shall satisfy the specifications and at a minimum contain the following information:

1. Equipment and method used by the Contractor to perform the work that may cause undue vibration.

2. Qualifications of Vibration Monitoring Specialist.

3. Details regarding proposed instrumentation.

4. Proposed location of instruments adjacent to existing structures, utilities, or other potentially vibration sensitive structures within a 250 m radius of the proposed work location and associated protection systems, as applicable.

5. Action Plan to be taken to adjust excavation methods and protection system installation methods if readings show vibration exceeding tolerable levels.

D. The Contractor shall complete and submit CCTV Inspection Reports for the FDC Storm Sewer System from STM MH 3 to STM MH 4 and the Sanitary Sewer System from Sanitary MH 2 to San MH 3 for both Pre-Construction and Post-Construction Conditions as per OPSS.Muni. 409.

1.6 QUALITY ASSURANCE AND CONTROL

A. Refer to Section 01400 – Quality Requirements.

B. Notify the Owner and the Consultant two (2) weeks , prior to installing monitoring devices.

C. Personnel employed for monitoring have at least four (4) years of direct field experience in construction monitoring using the proposed equipment.

1.7 EQUIPMENT

A. Portable ground vibration monitoring equipment:

1. All monitoring equipment shall be capable of measuring and recording ground vibration PPV up to 200 mm/s in the vertical, transverse, and radial directions. The equipment shall have been calibrated within the last 12 months either by the Manufacturer or other Qualified Agent. Proof of calibration shall be submitted to the Consultant prior to commencement of any monitoring operations.

PART 2. PRODUCTS – NOT USED

PART 3. EXECUTION

3.1 PREPARATION

A. A Pre-Construction Condition Survey and Post-Construction Survey shall be carried out for all existing structures and utilities as per the following:

1. Pre-Construction Condition Surveys:

a. The Standard Inspection Procedure shall include the provision of the explanatory letter to the Owner or Occupant and Owner with a formal request for permission to carry out an inspection.

b. A Pre-Construction Condition Survey, at each structure and utility within 50 m from construction limits of new works shall be completed in accordance with the Contract Documents. The Pre-Construction Condition Survey shall include the following, as a minimum:

i. Type of structure, including type of construction and if possible, the date when built.

ii. Identification and description of existing distresses such as settlements, differential settlements, visible cracks in walls, floors, and ceilings, including a diagram, if applicable. All other apparent structural and cosmetic damage or defect shall also be noted. Defects shall be described, including dimensions and location.

iii. Digital photographs or digital video or both, as necessary, to record areas of significant concern.

B. Photographs and videos shall be clear and shall accurately represent the condition of the property. Each photograph or video shall be clearly labelled with the location and date taken.

C. A copy of the Pre-Construction Survey limited to a single residence or property, including copies of any photographs or videos that may form part of the report shall be provided to the Owner and the Consultant.

1. Post-Construction Survey:

a. The standard inspection procedure shall include the provision of the explanatory letter to the Owner or Occupant and Owner with a formal request for permission to carry out an inspection.

b. The Post-Construction Condition Survey, at each structure and utility within 30 m from construction limits of new works shall be completed in accordance with the Contract Documents.

c. The Post-Construction Condition Survey shall include the following as minimum:

i. Identification and description of any settlements/deformations, inducing visible cracks in building walls, floors and ceilings including a diagram, if applicable. All other apparent structural and cosmetic damages or defects shall be noted. Defects, if any, shall be described, including dimensions and location.

ii. Digital photographs or digital video or both, as necessary, to record areas of significant concern.

iii. Compare between pre-condition survey documented concerns and post-construction concerns.

D. Photographs and videos shall be clear and shall accurately represent the condition of the property. Each photograph or video shall be clearly labelled with the location and date taken.

E. A copy of the Post-Construction Condition Survey limited to a single residence or property, including copies of any photographs or videos that may form part of the report shall be provided to the Owner and the Consultant. The report shall confirm that there have been no changes to the condition of pre-construction and post-construction as a result of the related construction activities on site.

1. Monitoring:

a. The vibration monitoring equipment shall be placed on the ground surface in the vicinity of each foundation element or protection system, and existing utilities, and on ground surface at radial distance of 25 m, and 40 m from the protection system location. The Contractor shall take readings continuously during construction activities and shall immediately notify the Owner and the Consultant if the vibration exceeds any of the limits specified in the Contract Documents, local bylaws, or below.

b. The vibration measured shall not exceed below limits.

Monitored Activity	Limits
Vibration in Buildings During: Daytime and Evening	PPV <8 mm/sec for frequencies between 1 – 4 Hz. PPV <15 mm/sec for frequencies between 4 – 10 Hz. PPV <25 mm/sec for frequencies between > 10 Hz. For older or heritage buildings reduce limits above by 50%.
Vibration in Buildings During: Night-time	PPV < 3 mm/sec for frequencies between 1 – 100 Hz.
Vibration in Utilities (as measured directly on the utility)	Modern Structures: PPV < 25 mm/sec for frequencies between 1 – 100 Hz. Older Structures: PPV < 10 mm/sec for frequencies between 1 – 100 Hz.

c. If readings are not within the limits specified in the Contract Documents, the Contractor shall find alternative method for installation until the vibration at the various locations are within the acceptable levels.

2. Vibration Monitoring Records:

a. The Contractor shall submit details of the vibration monitoring to the Owner and the Consultant including the following, as minimum:

i. Monitoring reports twice a week during construction.

ii. The time and duration of each reading.

iii. Construction operation/activity type (e.g., demolition work, excavation, and new construction activities including installation of support of excavation system).

iv. Details of exceedances and modifications to operations, as applicable.

v. Final Report containing all relevant data including Vibration Monitoring and Pre-Construction and Post-Construction Conditions Survey.

F. The Contractor shall complete CCTV Inspections for the FDC Storm Sewer System for both Pre-Construction and Post-Construction Conditions as per OPSS.Muni. 409.11

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. The Contractor shall develop and submit a comprehensive Monitoring Program to provide proactive and reliable measurements of ground movement, vibration, and noise during construction on site. This program must be designed to mitigate potential impacts of construction activities on surrounding structures and utilities.
The Monitoring Program should include:

1. The Contractor shall provide plans and sections indicating the location of the proposed monitoring points, numbers, and type of monitoring equipment in accordance with the Contract Documents.

2. Measurement Methods: Detailed description of the techniques and equipment used for monitoring ground movement, vibration, and noise, including the frequency of measurements.

3. Baseline Data Collection: Procedures for establishing baseline data for ground movement, vibration, and noise before construction begins.

4. Thresholds and Triggers: Defined thresholds for ground movement, vibration, and noise that, if exceeded, will trigger immediate assessment and appropriate mitigation measures.

5. Reporting Procedures: Specifications for reporting measurement results, including format, frequency, and distribution of reports to relevant stakeholders.

6. Mitigation Measures: Strategies for addressing and mitigating impacts if monitoring results exceed acceptable thresholds, including corrective actions and communication protocols.

7. Coordination and Communication: Procedures for coordinating with affected property Owners, utility providers, and other relevant parties to ensure timely response to any potential impacts.

1.2 REFERENCES

A. Ontario Provincial Standard Specification (OPSS) for Temporary Protection System (OPSS.MUNI 539).

B. City of Sudbury, Regulating Noise, By-law 2018-29.

1.3 SECTION INCLUDES

A. Labour, products, equipment and services necessary for reading instruments specified in Section 02020 – Monitoring Instrumentation and Equipment in accordance with the Contract Documents.

B. Instrument reading thresholds for the Owner/Consultant assessment of the progress of the work and its impact on the surrounding earth, utilities, and structures.

1.4 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Section 01010 – General Instructions.

B. Section 01061 – Environmental Considerations.

C. Section 01351 – Health and Safety.

D. Section 01400 – Quality Requirements.

E. Section 02020 – Monitoring Instrumentation and Equipment.

F. Section 02030 – Vibration Monitoring.

1.5 DEFINITIONS

A. Review Level: Value of instrumentation readings at which the Owner, the Consultant and the Contractor jointly assess necessity of altering method, rate or sequence of construction.

B. Alert Level: Value of instrumentation readings at which the Owner and the Consultant can order construction operations to cease, make site and affected properties secure, and take necessary and agreed upon measures to mitigate unacceptable movements and assure safety of work and public. Alert Level for each instrument represents maximum permissible ground and structure movement due to activities associated with construction of work, maximum groundwater level permitted during construction, maximum load or stress which may be imposed on elements of temporary Works system, or maximum vibration levels permitted.

C. Vibration and noise monitoring shall be carried out during construction activities especially during shoring installation system and demolishing process and all the limits shall not exceed the permitted levels.

D. Baseline Reading: Initial readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements and changes in stress or pressure.

E. Response Levels: Review and alert values as defined above and specified in Table 1, review and alert levels for instruments. Response levels encompass the cumulative movement, deformation, stress, strain, noise and water level changes from the baseline readings.

Table 1: Monitoring Review and Alert Levels

Instrument	Review Level	Alert Level
Building/Surface Monitoring Points for Structures	5 mm	10 mm
Utility Monitoring Points	3 mm	5 mm
Piezometers within Excavations	TBE*	TBE*
Noise Monitoring Points	As per City of Sudbury, Regulating Noise By-law 2018-29	

*TBE: To be established during construction at levels consistent with Open Standpipe Piezometers Response Levels.

PART 2. PRODUCTS – NOT APPLICABLE

PART 3. EXECUTION

3.1 DATA COLLECTION REQUIREMENTS

A. Participate in taking baseline readings of instruments as specified in Table 2 and acknowledge in writing acceptance of baseline readings. Take baseline readings before start-up of dewatering, shoring, excavation, rock removal, operation of heavy equipment, or any other construction activity that could cause ground movement, vibration to structures/utilities or noise.

B. Monitor and respond immediately to data that exceeds performance criteria, including response levels defined in Contract Documents.

C. Read and record data from instruments at frequencies indicated in Table 2, Monitoring Frequency; and for noise monitoring comply with the requirements in the Noise Control By-law of the City of Sudbury.

D. Monitoring data is to be completed at frequencies indicated in Table 2, Monitoring Frequency.

Table 2: Monitoring Frequency

Instrument	Baseline Reading	Subsequent Readings
Building/surface monitoring points for structures	Average of three readings immediately upon installation prior to excavation or other construction activity.	Daily, at every three (3) hours duration, during excavation, dewatering and backfilling.
Utility monitoring points		
Noise level		
Open Standpipe Piezometers (OSP)	Average of two sets of readings at least two (2) weeks prior to start of dewatering or start of excavation or another construction activity.	Daily continuous while dewatering system remains in operation. Weekly thereafter until groundwater level recovers to pre-construction levels or completion of backfilling, whichever occurs first.

E. Monitoring frequencies in Table 2 may be modified by the Owner/Consultant at any time, depending on location, construction progress, scheduling and efficiency of temporary works, construction rates of movement, and other factors affecting of earth or structures that are subject to monitoring.

F. Monitoring frequency does not indicate monitoring required for Contractor's control or safety of construction. Perform monitoring necessary for safety and performance of construction operations.

G. Take independent readings of instruments as needed for safety and control of construction after giving adequate notice to the Owner and the Consultant.

H. Install access and provide necessary assistance to the Owner/Consultant when the Owner/Consultant finds it necessary to take independent readings of instruments installed by Contractor.

1. Submit data on weekly basis from instruments read by Contractor to the Owner and the Consultant in accordance with the Contract Documents.

2. Submit electronic instrumentation monitoring data, including Contractor's data to the Owner and the Consultant. In addition to parameters being measured, such as x, y and z co-ordinates for survey data, include date, time, temperature, instrument name and number, location, name of person(s) taking readings and other pertinent data required by the Owner/Consultant. In addition, when requested submit hardcopy of each round of monitoring data to the Owner/Consultant. Maintain complete record of monitoring data on-site in compatible form to above.

3.2 DISCLOSURE OF DATA

A. Do not disclose any instrumentation data to third parties and do not publish data without prior approval and written consent of the Owner/Consultant.

3.3 INTERPRETATION AND USE OF DATA

A. Be responsible for interpretations of monitoring program data where it is used to control safety and operations or to meet Contract Documents, include making correlations between instrumentation data and specific construction activities.

B. Evaluate instrumentation data to determine whether response to construction activities is reasonable.

3.4 RESPONSE ACTIONS

A. If review level is reached:

1. Meet with the Owner to discuss response action(s) and develop a review-level response plan of action.

2. Implement reviewed and accepted review-level response plan of action.

3. Alert levels are not to be exceeded. Activities may be suspended in affected area with exception of those actions necessary to avoid exceeding alert level or to make the work and affected properties safe and secure.

B. If alert level is reached:

1. Work may be stopped by the Owner/Consultant. The Contractor shall bear any, and all costs associated with such work stoppage.

2. Meet with the Owner to discuss response action(s) and develop an alert-level response plan of action.

3. Remediation action may be required to correct any movement exceedance with no additional cost to the Owner.

4. Install and monitor additional instruments as directed by the Owner/Consultant.

5. Implement reviewed and accepted alert-level response plan of action.

END OF SECTION

PART 1. GENERAL

1.1 INTENT OF SECTION

A. Section includes demolition, salvage, and modifications of existing structures, block walls, cladding, roofing, piping, dry well and equipment as indicated on the Drawings.

1.2 GENERAL

A. Coordinate the work with the Consultant, Operator, and the City officials to minimize disruptions to operations of the existing pumping station. Include the sequence of removals in the project schedule for review by the Consultant.

B. Do not begin removals except in accordance with the accepted sequence of construction and until instructions has been given by the Consultant in writing three (3) weeks prior to removal.

C. All removed equipment, piping, materials, fixtures, hardware, supports, etc., to be disposed of by the Contractor unless marked in the field by the Authorities concerned. The Authorities has the first right of refusal. The Contractor is to request that the Owner mark items to be salvaged, at least three (3) weeks prior to removal.

D. All equipment to be removed by the Contractor is to remain in good working order.

E. Materials to be turned over to the Authorities shall be delivered and off loaded into storage within a 10 km radius of the construction site.

F. All facilities in the work area which are not to be removed must remain in continuous use during the work.

G. Demolition and salvage work shall create a minimum of interference with the Owner's operation and inconvenience to the Owner and to allow continuous, uninterrupted operation of the existing facility.

H. Blasting will not be permitted.

I. Perform Non-Destructive Testing (NDT) (scanning and/or x-ray) of all concrete slabs and walls schedule prior to demolition and get Consultant's review as applicable.

J. Perform Non-Destructive Testing (NDT) (scanning or x-ray) on all portions of concrete walls or slabs that are specified to have holes/penetrations or sufficient modifications made to them.

K. Demolition with jack hammering is not permitted.

L. Provide and design temporary supports, beams, jack supports prior to demolition where called for on Contract Drawings and as required to ensure safety and maintain integrity of existing structure(s). All design of temporary structures must be carried out by a Professional Engineer licensed in the Province of Ontario with minimum five (5) years' experience in similar works.

1.3 REGULATORY REQUIREMENTS

A. Obtain and pay for demolition permits. Give required notices. Take responsibility as Engineer of Record responsible for demolition.

B. Blasting will not be permitted.

C. Comply with requirements of CSA-S350-M1980 "Code of Practice for Safety in Demolition of Structures."

D. Comply with applicable regulations of jurisdictional authorities governing waste management.

1.4 SUBMITTALS

A. Submit for approval Drawings, Diagrams or details showing sequence of disassembly work and/or temporary supporting structures and underpinning. Drawings for structural elements shall bear seal and signature of Professional Engineer licensed to practice in Ontario.

B. Prepare and submit a Waste Reduction Work Plan. Describe management of demolition wastes. Identify materials which can be reused, recycled and indicate method proposed for reducing and reusing recycling wastes.

1.5 PROTECTION

A. Prevent uncontrolled movement, any part of building being demolished; provide temporary shoring and bracing required.

B. Take steps to positively prevent uncontrolled falling of demolished materials.

C. Ensure that no part of existing structure is overloaded due to work carried out under this Section.

D. Prevent debris from blocking drainage systems.

E. Ensure the temporary guards, hoardings are provided during and upon completion of work in accordance with applicable safety regulations.

1.6 EXAMINATION

A. Visit the site and the existing facility so as to fully understand all existing conditions and extent of work required. No increase in cost or extension of performance time will be considered for failure to know conditions.

B. Take over buildings and structures to be demolished based on their condition at time of bid submission, except where indicated otherwise.

1.7 CO-ORDINATION

A. Coordinate all demolition and modification work with any new work to be performed to facilitate completion. Demolition work cannot start until approved by the Consultant. Coordination is required with the Consultant and the City of Greater Sudbury's Operation staff.

B. Coordinate modification work and demolition to allow continuous, uninterrupted operation of the existing facility.

PART 2. PRODUCTS – NOT USED

PART 3. EXECUTION

3.1 PREPARATION

A. Ensure that affected structures and building areas are unoccupied and discontinued in use and that required screens, partitions, hoardings are in place prior to start of demolition work.

B. Verify that existing services in areas affected by demolition are disconnected, capped or removed, prior to start of work.

C. Ensure that all process equipment within demolition areas, either to be removed or retained, is appropriately protected from damage, dust or anything else which may cause damage during the demolition works.

3.2 ASBESTOS AND LEAD REMOVAL

A. Asbestos and Lead removal shall be completed in accordance with OBC Code and HSA Standard Procedures. Contractor shall satisfy him/herself with the site conditions based on the Designated Substances Survey.

3.3 GENERAL DEMOLITION REQUIREMENTS

A. The general area in which the demolition work is to be performed shall be left clean and free of debris at the end of each shift; access routes must always be kept clear. If required, the general area shall be graded as required to provide a uniform appearance.

B. All backfilling required in the demolition area shall conform to the governing requirements of the Earthwork Section.

C. Demolish existing work as indicated and as required to accommodate new work.

D. Demolish work in a safe and systematic manner, from top to bottom.

E. Do not throw or drop demolished materials from heights. Use chutes, conveyors or hoisting equipment to lower materials.

F. Demolish in a manner to minimize dusting. Keep dusty materials wetted but prevent flooding or contaminated runoff.

G. Demolish masonry and concrete elements in small sections. Carefully remove and lower structural framing and other heavy and large objects.

H. At all times leave work in safe condition, so that no part is in danger of uncontrolled toppling or falling.

I. Install temporary supports as required to prevent uncontrolled collapse of structures. Design of support to be completed by Professional Engineer licensed to practice in Province of Ontario with minimum five (5) years' experience in similar works. Submit stamped Plans and Drawings for review and record.

J. Security of the facility and operation must always be provided.

3.4 CONCRETE STRUCTURES DEMOLITION

A. Existing concrete structures, as noted, shall be removed to the limits indicated.

B. Existing concrete to be removed shall be cut into fragments and reduced in size as required to facilitate removal and disposal.

C. Disassembly and removal of all structural elements shall be carried out under the supervision of a Professional Structural Engineer licensed to practice in Ontario hired by the Contractor.

3.5 PIPING AND EQUIPMENT DEMOLTION

A. Be responsible for the removal of process equipment, pumps and associated motors, piping and valves, and all other appurtenances associated with the item being removed.

B. Existing piping shall be cut, removed, abandoned, disconnected, and/or salvaged as indicated on the Drawings or as required.

C. Piping and equipment shall be disconnected, dismantled and removed as required and in such a manner as to minimize disturbance or damage to adjacent construction.

D. At any point or location where, new work is to be connected or installed, the removal of existing work shall be done so as to facilitate the new installation work to the maximum possible extent.

3.6 SITE WORK DEMOLITION

A. The demolition of existing drives, curbs, walks, dikes and similar items shall be scheduled and performed to minimize inconvenience to the Owner.

B. The attention of the Contractor is called to the Summary of Work Section pertaining to the construction sequence guidelines that are recommended to maintain pumping station operations.

C. The demolition of existing in ground services including piping and chambers shall be coordinated so as to ensure the continual unhindered operation of the pumping station, allow for efficient changeovers from existing to new in ground services and to minimize inconvenience to the City of Greater Sudbury.

3.7 REPAIR OF EXISTING CONSTRUCTION

A. Where structures to be demolished are connected to structures to remain, remove the existing construction in a careful manner so that adjacent construction, piping or facilities to be left in place are not cracked or damaged.

B. The Contractor will be held responsible for any damage thereto because of his operations.

C. Use temporary supports designed by a Professional Engineer, where and as required for the support of existing facilities and structures.

D. Holes and damages resulting from removal operations shall be filled, reconstructed, repaired, and finished to match and conform to adjacent surfaces and construction as determined by the Consultant.

3.8 ELECTRICAL REMOVAL

A. The control stations, control panels, conduits and other devices associated with the removed equipment may not be shown on the Drawings.

B. Contractor to ensure that pumping station operation is not affected due to loss of power to any part of the station.

C. The Electrical Subcontractor shall be responsible for the following items:

1. Disconnecting electrical power sources from all equipment and devices to be moved or removed.

2. Removing electrical conductors from the conduits serving the equipment to be moved or removed.

3. Removing local starters, control stations, control panels and other local control devices not an integral part of the associated equipment to be moved or removed.

4. Disconnecting and removing abandoned motor control centres, and motor control line-ups.

5. Removing exposed conduit connecting equipment and devices to be moved or removed and the power sources.

6. Where abandoned conduit not indicated to be retained for future use enters a structural surface above the operating floor, it shall be undercut 25 mm with edges dovetailed and the structure tightly and neatly repaired to resemble the remaining surface.

7. Where such a conduit enters a structural surface below the operating floor, it shall be cut flush with the floor or within 25 mm of other surfaces, and those in floors and walls filled with expanding grout to a depth of one diameter, but 50 mm minimum.

8. On any equipment to be reapplied or abandoned in place, unused conduit openings shall be plugged, and original identity nameplate shall be reversed or removed. Circuit lists and nameplates at sources of power shall be neatly corrected for changes in loads. Electrical items in motor control centres, control panels, panel boards, etc., separate from abandoned equipment shall be left as spares, unless indicated otherwise.

9. Existing status and control panels shall be disconnected, removed, and returned to the Owner.

D. Remove abandoned power cable, electrical control panels, and power distribution equipment as required. Coordinate this work with the City of Greater Sudbury and the Consultant.

E. Abandoned conduits in good condition and at least as large as indicated for new circuits may be used as part of contract installation.

F. Salvaged items to be reinstalled or delivered to the City of Greater Sudbury's on-site storage shall be handled carefully.

G. Removed electrical equipment shall first be offered to the City of Greater Sudbury and if the City of Greater Sudbury refuses right to Ownership, the equipment shall be disposed of offsite by the Contractor.

H. Coordinate with Greater Sudbury Utilities (GSU) for removals scope.

3.9 ITEMS TO BE SALVAGED BY CONTRACTOR

A. Removal and salvage of any item of equipment or facility includes removal and salvage of all accessories, piping, wiring, supports, associated electrical starters and devices, base plates, and frames and all other appurtenances, unless otherwise directed.

B. Existing materials and equipment removed, and not reused as a part of the work, shall become the Contractor's property, except for the items indicated by the Owner shall remain the Owner's property and shall be delivered to the Owner to a designated area by the Contractor in good condition.

C. Existing materials and equipment to be removed by the Contractor, and reused as a part of the work shall remain the property of the Owner.

D. The Contractor shall carefully remove, in a manner to prevent damage, all materials and equipment specified herein or indicated to be salvaged and reused or to remain the property of the Owner.

E. The Contractor shall store and protect salvaged items specified or indicated to be reused in the work.

F. Any items damaged in removal, storage, or handling through carelessness or improper procedures shall be replaced by the Contractor in kind or with new items.

G. The Contractor may, at his option, furnish and install new items in lieu of those specified or indicated to be salvaged and reused, in which case such removed items will become the Contractor's property.

H. All other existing materials and equipment removed by the Contractor shall not be reused in the work, shall become the property of the Contractor, and shall be removed from the jobsite.

3.10 INSTRUMENTATION

A. Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring or holes that remain after removal of equipment and associated support hardware shall be removed or repaired in a manner acceptable to the Consultant.

B. Transmitters or switches containing mercury shall be removed and disposed of in an approved manner and by personnel knowledgeable about appropriate methods of handling mercury.

3.11 CONCRETE MODIFICATIONS

A. Remove existing concrete where such removal is indicated on the Drawings or directed by the Consultant.

B. Remove all dust, grease, curing compounds, impregnations, waxes, foreign particles and disintegrated materials.

C. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Feather edges will not be permitted.

D. Remove all defective existing concrete down to sound concrete where indicated on the Drawings or as directed by the Consultant.

E. Where existing concrete is to be removed, fill, repair and finish the surfaces smooth and flush with adjacent undisturbed surfaces.

F. Unless otherwise indicated on the Drawings or directed by the Consultant, clean and leave in place existing reinforcing exposed during concrete removal operations.

G. Where indicated on the Drawings, extend existing reinforcing into the new construction by mechanical connection to the existing reinforcement. Mechanical connections shall be used as specified in Division 3 unless otherwise shown differently on the Contract Drawings.

H. Any reinforcement bars the Consultant allows to be cut shall be cut off not less than 50 mm inside the finished and repaired surface. All anchor bolts, piping and other hardware projecting from concrete surfaces after piping and equipment have been removed shall be cut 50 mm inside the finished or repaired surface. Reinforcement bars and other steel construction to be removed by flame-cut.

I. Remove concrete bases of existing equipment that have been relocated or removed, down to the reinforcing steel of the supporting slab. Initiate removal of curb base with a concrete saw, cutting around the perimeter, taking care not to chip or spall the surface of remaining structure. After existing materials have been removed, exposed reinforcing steel and structural slab shall be cleaned and filled with new concrete, finished to match the surrounding surface.

J. Concrete materials and placement shall be in accordance with the Cast-In-Place Concrete Section. Grouting shall be in accordance with the Grouting Section.

K. Provide dust control by water systems or vacuum systems and tarping to limit any dust migration during any concrete demolition works.

3.12 DISPOSAL AND CLEAN-UP

A. With the exception of items designated for salvage or reuse, all materials, rubbish and debris resulting from demolition work shall become the Contractor's property and shall be removed from site and legally disposed of unless specifically indicated otherwise.

B. Do not allow demolished materials to accumulate on site. Promptly, as work progresses, remove and legally dispose of materials away from site.

C. Separate and salvage materials suitable for reuse and/or recycling from general waste stream or non-salvageable items. Transport and dispose of non-salvageable items to licensed disposal facility.

D. Provide on-site facilities for collection, handling and storage of anticipated quantities of reusable and/or recyclable materials.

E. Locate containers in locations, to facilitate deposit of materials without hindering daily operations.

F. Collect, handle, store on-site and transport off-site, salvaged materials, salvaged for reuse and/or recycling in separate condition. Transport to authorized reuse/recycling location.

G. Burying, burning, selling waste materials on site is prohibited.

H. Disposal of liquid wastes into waterways, sewers is prohibited.

I. Clean-up work, storage and waste collection areas as work progresses.

J. Contractor shall be responsible for all cleaning of existing piping, equipment, and structures that is required to properly remove and dispose of items to be demolished.

3.13 FIELD QUALITY CONTROL

A. Disassembly, removal of structural elements shall be carried out under the supervision of a Professional Engineer licensed to practice in Ontario.

END OF SECTION

PART 1. GENERAL

1.1 DESCRIPTION OF WORK AND INTENT

A. Control of groundwater and surface runoff during construction including demolition work.

B. Installation of markers for monitoring movements of existing structures.

C. Discharge of drainage water from construction site, including installation and maintenance of discharge pipe and siltation ponds.

D. Coordinating dewatering work with requirements of other trades and units of work affected by dewatering operations.

E. Provide submittal requirements.

1.2 RELATED SECTIONS

A. Division 1 – General Requirements.

B. Section 02030 – Vibration Monitoring.

C. Section 02040 – Monitoring Program.

D. Section 02315 – Excavating, Trenching and Backfilling.

E. Section 02150 – Bracing and Shoring.

F. Section 02723 – Granular Base and Sub-Base.

G. Section 03300 – Cast-In-Place Concrete.

1.3 PAYMENT

A. All costs for items specified are to be included in the total Lump Sum Tender Price.

B. No additional payment will be made for dewatering in areas where sub-excavation may be required.

1.4 GEOTECHNICAL REPORTS

A. A Soils Report will be appended to the Contract Document for information purposes. Refer to Division 1 – General Requirements.

B. Take full responsibility for interpretation of available soil information, planning and execution of the dewatering and shoring work.

C. City accepts no responsibility for the accuracy of the borehole information. Claims arising from the interpretation of available information will not be considered.

1.5 DESIGN AND PERFORMANCE REQUIREMENTS

A. Engage a Professional Engineer or a Professional Geoscientist (P.Geo.) licensed in Ontario with demonstrated competence to design, construct, monitor and maintain the dewatering system.

B. Engage the services of a Specialist Dewatering Contractor who has minimum five (5) years' experience in design and construction dewatering and discharging systems for projects of similar size and complexity in Ontario.

C. Coordinate design of dewatering systems with bracing and shoring systems per Section 02150 – Bracing and Shoring to meet performance requirements.

D. Dewater and keep excavations free of water to permit construction activities to proceed on firm dry subgrade.

E. For structures and trenches, maintain groundwater level at least 1000 mm below underside of foundation and trench invert or lower as may be required to fulfil the requirements of these Specifications.

F. Prevent destabilization, heaving and shearing failure of the bottom of excavation by dewatering groundwater.

G. Prevent damage to or displacement of adjacent structures and utilities (within 50 m radius off construction site) from effects of groundwater drawdown. Refer to specification Sections 02030 and 02040 for movement and vibration monitoring requirements and Monitoring Plan Drawing provided within Contract Documents.

H. Contractor shall make best effort and care to dewater work, discharge requirements and reporting procedures.

I. Repair or replace any structure, pipeline or other works damaged due to inadequate dewatering to the satisfaction of the Owner/Consultant at no expense to the Owner.

J. Unless otherwise authorized in writing by the Owner/Consultant, continue dewatering operation until backfill material around the structures is in place to the design elevation.

K. Design and operate the dewatering and shoring system to remain within the Permit to Take Water (PTTW) and the limit of permissible discharge of groundwater to the sanitary sewer.

L. Develop, provide and obtain approval for a Contingency Plan to minimize damage to site works in the event of failure of the dewatering system or failure to meet the terms and conditions of the Permit to Take Water or the Site Mitigation Plan.

1.6 DEWATERING DISCARGE REQUIREMENTS

A. Provide appropriate filter screens so that no soil or foundation material is removed and an objective solids concentration of less than 5 mg/L in the discharge water is met. Do not exceed solids concentration of 10 mg/L at any time.

B. Discharge water from surface runoff collection and dewatering operation through sedimentation pond or other means, including but not limited to bag filters, temporary settling tank.

C. The Contractor, at his own expense will carry out physical and chemical analysis of drainage water to establish conformance with these Specifications. If required, the Contractor will treat the drainage water before discharging to reduce content of solids and chemicals at his own expense.

1.7 SUBMITTALS

A. Qualifications of the Dewatering Contractors.

B. Submit a General Plan of Dewatering Scheme which includes:

1. Location of generators and other noise producing equipment and anticipated decibel levels.
2. Relationship between dewatering equipment, including the portable settling tank, existing structures and the excavation plan.
3. Location of dewatering discharge points.
4. Location of groundwater observation wells.
5. Proposed flow rate for each well complete with flow meters to be utilized for monitoring flow.
6. Monitoring schemes complete with location of monitoring points.
7. Details of backup power system and dewatering system redundancy.
8. Proposed layout of discharge pipe to the storm pond.

9. Include signature and seal of the Professional Engineer or Geoscientist responsible for design and supervision of the dewatering system, on all submission items.

C. The Contractor shall maintain a record of all water takings during the construction activities. The Contractor shall submit water taking records to the Consultant. The records of water takings will include the following:

1. Date and duration of dewatering activities.

2. The total measured amounts of water pumped per day.

3. Provide location of the water taking.

4. Submit the records weekly.

5. The Contractor shall request approval for the format of the submission of dewatering flows prior to first submission.

6. The Contractor shall submit a Contaminant Handling and Spills Management Plan containing measures to ensure protection of groundwater and surface water resources and also poor water quality discharge procedure.

7. These submittals are for record purposes only and will not be reviewed for adequacy. The total flows may be submitted to the Ministry of the Environment.

1.8 PERMITS

A. Water takings greater than 50 m^3/day normally require a Permit To Take Water (PTTW), before the water can be taken. However, Ontario Regulation 64/16 was brought into force on March 29, 2016, which provides exemptions to construction dewatering activities, provided that certain conditions are met. Contractor to confirm if the project meets the exemption requirements, provided that the discharge water can be accepted by the City storm water sewer system and water takings will be less than 400 m^3/day; otherwise apply for PTTW.

B. Refer to Division 1.

PART 2. PRODUCTS

2.1 EQUIPMENT

A. Dewatering Equipment:

1. Pipes, wells, deep wells, well-points, pumps, electrical generators and other equipment as required to de water in accordance with the requirements of this Section.

2. Standby pumps and a generator with effective muffling devices to keep noise levels to levels specified.

PART 3. EXECUTION

3.1 INSTALLATION

A. Dewatering Equipment:

1. Install dewatering equipment and dewatering to required level before proceeding to excavate when excavation will be made into sands, silts, and gravel layers.

2. Take corrective measures as necessary to maintain groundwater level at a level necessary to meet performance requirements.

B. Groundwater Monitoring Wells:

1. Install and maintain one 50 mm new monitoring well including protective casing. Monitoring well to be suitable for monitoring groundwater at least 3,000 mm below the foundation. The location will be provided by the Consultant.

2. Preserve and protect existing monitoring wells as necessary.

3. Decommission all of the monitoring wells and piezometers in advance of the work in accordance with O.Reg. 903. Documentation must be provided to the City.

C. Movement Monitoring Markers:

1. Install and maintain markers to monitor horizontal and vertical movements of existing structures. Take measures to prevent damage to existing structures. Repair damaged to structures due to dewatering at no cost to the City. Submit copies of the record to the Consultant weekly. Establish two independent deep seated benchworks within reasonable sighting distance of each structure to be monitored.

Protect benchworks during course of construction.

3.2 DEWATERING DISCHARGE REQUIREMENTS

A. Provide appropriate filter screens so that no soil or foundation material is removed and the objective total suspended solids concentration of less than 5 mg/L in the discharge water is met. Do not exceed solids concentration of 10 mg/L at any time.

B. Discharge water from surface runoff collection and dewatering operation through sedimentation ponds and enviro-tanks.

C. The Contractor, at this own expense, will carry out the physical and chemical analysis of the drainage water to establish conformance with these Specifications.

D. The Contractor shall divert the dewatering discharge to sanitary sewer, as directed by the Consultant, when the water quality testing from the nest of monitoring wells is within 80 percent of Provincial Water Quality Objective Values.

3.3 FLOTATION OF STRUCTURES

A. Maintain groundwater at a sufficiently low level to prevent damage or displacement of structures by groundwater pressures.

B. Protect completed structures or part of completed structures which would suffer displacement or other damage as a result of dewatering equipment failure by providing:

1. Standby dewatering equipment connected directly to electrical generators which will engage automatically in case of power failure.

2. A positive means by which the structures may be flooded with water to neutralize exterior hydraulic pressures.

3. A combination of the two alternatives above.

3.4 MONITORING GROUNDWATER LEVEL

A. Take readings or groundwater level three times a day for the duration of the dewatering period. Keep a written record of groundwater levels. Submit one (1) copy of the records to the Consultant at the end of each week of operations.

B. Maintain a log of the water takings. This record shall include the dates and times of water takings and the total measured amounts of water pumped per day that water is taken under the Permit to Take Water and as per submitted requirements of this Contract. All water taking records shall be kept on-site at all times and shall be available for inspection by the Owner or by a Professional Officer immediately upon request.

3.5 MONITORING MOVEMENTS OF EXISTING STRUCTURES

A. Take readings prior to, during, and after dewatering operations (a minimum of once daily) to record horizontal and vertical movements with respect to an established reference point for the duration of the dewatering period.

B. Monitoring of movements is applicable for existing structures (including any houses) and utilities within 50 m radius off construction site.

END OF SECTION

PART 1. GENERAL

1.1 SUMMARY

A. Comply with Division 1 – General Requirements.

B. This Section includes:

1. Protection of existing and new structures, services, utilities and foundations from damage or displacement.

2. Designing, supplying, placing and removal of the temporary shoring system for excavation sides.

3. Underpinning and temporary supports for existing structure or utilities in order to execute the construction of the permanent works.

4. Excavation shoring for yard piping.

C. Related Sections include:

1. Section 01040 – Summary of Work and Coordination.

2. Section 01061 – Environmental Considerations.

3. Section 02030 – Vibration Monitoring.

4. Section 02040 – Monitoring Program.

5. Section 02315 – Excavating, Trenching and Backfilling.

6. Section 03300 – Cast-In-Place Concrete.

1.2 REFERENCES

A. Comply with the following Statutes, Codes and Standards, and all related amendments.

1. A23.1/A23.2 – Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

2. G40.20/G40.21 – General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel.

3. CAN/CSA-S16, Design of Steel Structures.

4. OPSS 903 Latest Revision, Construction Specification for Deep Foundations.

5. OPSS.MUNI 539, Construction Specification for Temporary Protection Systems

6. Canadian Foundation Engineering Manual (CFEM), Fourth Edition.

7. Regulations for Construction Projects, Ontario Regulation 213/91, made under the Occupational Health and Safety Act, Revised Statutes of Ontario, 1990, Chapter O.1.

8. Geotechnical Investigation Report prepared for the project is appended to the Contract Document for information purposes.

1.3 DEFINITIONS

A. Temporary Structures: Structures of a short-term nature, such as excavation shoring systems, vertical or lateral shoring of existing structures or utilities, and similar systems which will be required in order to execute construction of the permanent works.

B. Excavation Shoring System: A temporary structure, such as steel liner plates, steel-sheet piling, soldier piles and lagging, concrete slurry walls, steel rib and lagging or similar systems required to retain earth and water in order to facilitate construction of the permanent works.

1.4 SYSTEM DESCRIPTION

A. Design Requirements:

1. The design shall be based on the geotechnical requirements of the Site and Structural Design Codes of Practice. Refer to the Geotechnical Investigation Report mentioned in 1.2 above, included with, but not forming a part of, the Contract Documents. The opinions expressed in this report are those of a Geotechnical Engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a Geotechnical Engineer. The Contractor shall be responsible for the interpretation of any data included with the Geotechnical Report.
The Owner will not be responsible for any interpretations or conclusions drawn by the Contractor from this data. The Contractor shall make any additional test borings and conduct other exploratory operations necessary to complete the work at his own cost.

2. Consider applicable loads and load combinations, including lateral pressures from groundwater, soil, unsymmetrical surcharge loads from construction operations and frost action on retained soil and other loads indicated on the Contract Documents as applicable.

3. Limit deflections of the excavation shoring systems that retain materials and support foundations at a higher elevation, so that retained material is not disturbed or weakened.

4. Bracing to remain fully effective during construction. Pre-stress bracing, if required, to control deflection within the limits specified in the Contract Documents.

5. Coordinate design, installation of the shoring system, dewatering system and the excavation to meet the performance requirements specified in the Contract Documents.

6. Sequencing of the work should be shown on the Shoring Shop Drawings.

7. The Contractor shall engage a Professional Engineer licensed in the Province of Ontario (with minimum of five (5) years experience of similar work) to carry out the analysis and design of shoring systems. The design shall be based on actual site conditions. Surcharge shall be calculated in accordance with the Ontario Building Code OBC, and additional loads where noted on the Contract Structural Drawings.

8. Design the excavation shoring system to comply with OPSS.MUNI 539 Performance Level 1a and limit deflection and/or movement to a maximum of 5 mm maximum at the top of the shoring.

9. Design splices in Walers and bracing beams in accordance with the requirements of CAN/CSA-S16.

B. Performance Requirements:

1. Design, furnish, install, monitor, maintain excavation support systems capable of supporting excavation sidewalls, resisting soil pressure, hydrostatic pressure, superimposed loads and construction loads.

2. Shoring system to be watertight to the extent that any dewatering required inside the excavation shall not lower the water table on outer side of the shoring system.

3. Prevent surface water from entering excavations by grading, dikes or other means.

4. Install excavation support systems without damaging existing utilities, structures and site improvements adjacent to excavation.

5. Labour, products, equipment and services necessary for the installation of shoring and underpinning shall be in accordance with the Contract Documents.

6. Monitor vibrations, settlements, and movements of the shoring system and report to the Consultant for review/record.

7. The design of the shoring system must be such that the excavation and shoring system installation does not result in a settlement of more than 5 mm in adjacent buildings/utilities (within 50 m of excavation sides) or an angular deflection of more than 1/500 in buildings, structures or nearby buried pipelines.

1.5 SUBMITTALS

A. Shop Drawings:

1. Submit Shop Drawings for temporary shoring/bracing system and excavation shoring for the Consultant's review and record.

2. Shoring/bracing system and excavation shoring design will not be reviewed for structural adequacy. Full responsibility for the design, installation, and maintenance of excavation and shoring systems rests with the Contractor.

3. The Shop Drawings shall include details and connections, design criteria, construction method, sequence, and the means by which existing structures, utilities and equipment will be protected. The Shop Drawings shall be stamped and signed by a Contractor's Professional Engineer licensed in the Province of Ontario having experience in the design and construction of shoring systems (minimum experience of five (5) years in similar projects in Ontario).

4. Submit design calculations of excavation shoring system if requested by the Consultant.

5. Indicate the following on the Excavation Shoring Shop Drawings:

    a. General arrangement of the shoring system.

    b. Design loadings.

    c. Dimensions and elevations of shoring.

    d. Installation and deflection tolerances.

    e. Material sizes, designations, and grades.

    f. Relationship of the shoring system to the new and existing structures, services, and utilities.

    g. Method and details of the installation of the shoring system.

    h. Location of secant piled wall system, temporary struts and Walers relative to permanent structures.

    i. Schedule for removal of temporary struts, Walers and steel-sheet piling.

B. Excavation Shoring System Deflection Records:

1. Submit a copy of written records of the daily readings of deflections of the excavation shoring system to the Consultant on a weekly basis.

2. Submit inspection reports of the installed shoring system signed by the Shoring Design Engineer.

1.6 QUALTY ASSURANCE

A. The Contractor shall engage a Registered Professional Engineer, licensed to practice in Ontario, to design, supervise the installation of, and inspect the shoring system.

B. Submit inspection reports of the installed shoring system signed by the Shoring Design Engineer.

C. Pre-Installation Meetings: A minimum of 14 days prior to commencing the work of this Section, arrange for each respective Manufacturer's Technical Representative to review with the Contractor and the Consultant the procedures to be adopted, conditions under which the work will be done, in order to ensure that any alternate recommendations may be made should adverse conditions exist.

D. Review:

1. Construction schedule and verify availability of materials, installer's personnel, equipment, and facilities necessary to make progress and avoid delays.
2. Geotechnical Report.
3. Existing utilities and subsurface conditions.
4. Proposed excavations.
5. Proposed equipment.
6. Monitoring of excavation support system
7. Working area location and stability.
8. Coordination of dewatering system.

E. Welders: Must be certified per CSA-W47.1.

1.7 COORDINATION

A. Co-ordinate the work with the requirements of other related Sections of the Contract Specifications.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by the Owner unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated in the Contract Documents:

1. Notify the Consultant a minimum of 20 days in advance of proposed interruption of any utility.

2. Do not proceed with interruption of any utility without the Consultant's written permission.

B. Project Site Information: The Geotechnical Report in Subsection 1.2 has been prepared for this project and is included with, but does not form a part of, the Contract Documents for information only. The opinions expressed in this report are those of Geotechnical Engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a Geotechnical Engineer. The Contractor shall be responsible for the interpretation of any data included with the Geotechnical Report. The Owner will not be responsible for any interpretations or conclusions drawn by the Contractor from this data.

1. The Contractor shall make any additional test borings and conduct other exploratory operations necessary to complete the work at his own cost.

C. Survey Work: Engage a qualified land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks and record existing elevations.

D. During installation of excavation support systems, resurvey benchmarks at two weekly intervals, maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Consultant with a condition survey if changes in elevations or positions occur or if cracks, sags or other damage is evident in adjacent construction.

PART 2. PRODUCTS

2.1 MATERIALS

A. Utilize materials conforming to the submitted designs.

B. Steel-Sheet Piling: CAN/CSA-G40.20-M; Hot-Rolled, Interlocking Type.

C. Structural Steel: CAN/CSA-G40.21-M; Grade 300W and Grade 350W.

D. Concrete for Caisson Wall: CAN/CSA-A23.1 and A23.2.

E. Reinforcing Steel Rebar for Caisson Wall: CAN/CSA G30.18 Grade 400 Deformed Bars.

F. Welding: CSA W59-M.

G. Lumber:

1. Graded lumber, sound, straight and free from cracks, shakes and large or loose knots.

2. Planks for Sheeting: Tongued and grooved or grooved and splined.

PART 3. EXECUTION

3.1 INSTALLATION

A. Carry out temporary shoring in accordance with regulations for construction projects, Ontario Regulation 213/91, made under the Occupational Health and Safety Act, Revised Statutes of Ontario, 1990, Chapter O.1.

B. Obtain clearance information on buried utilities and structures, which can potentially conflict with the shoring, prior to proceeding with shoring installation. Such utilities and structures shall be indicated on the Shop Drawings for the shoring.

C. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards that may develop during excavation support and system operations.

D. Shore, support, and protect any utilities encountered.

E. Install excavation support systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

F. Install excavation shoring and bracing systems, as required by the soil conditions, the Excavation Plan in accordance with Section 02315 – Excavating, Trenching and Backfilling, and the Occupational Health and Safety Act – Part III – Excavations of the Regulations for Construction Projects, to prevent cave-ins of the banks and sides of excavations.

G. Excavation shoring is mandatory for where indicated on the Contract Drawings:

1. Around structures.

2. Where indicated on the Drawings.

3. In areas where excavation will potentially undermine existing structures, pipes, services, utilities or roads.

H. Do not install excavation shoring or bracing systems until permission has been given by the Consultant to proceed.

I. Provide adequate working room within shored excavations.

J. Shoring Systems Tolerances:

1. Cut-off elevation ±25 mm.

2. Horizontal location at cut-off not more than 5% of shaft diameter or 75 mm, whichever is smaller.

3. Verticality tolerance shall be within 1 in 200.

K. Where shoring is used as formwork for concrete structures, verify that shoring in its deflected position does not reduce the thickness of structural concrete. If the excavation shoring system, as installed, reduces the thickness of structural concrete, alter shoring at no additional cost to the Contract until shoring installation meets the above requirements.

L. Install shoring so that there is no loose material or voids between the shoring and the sound undisturbed soil behind.

M. Promptly repair damages to adjacent facilities caused by installing excavation support systems.

N. Braced Timber Shoring:

1. Provide struts, Walers and sheathing to match the submitted designs.

2. Jack and wedge struts against Walers and sheathing to ensure full contact and support to the adjacent ground.

3. Fill voids between the sheathing and firm undisturbed ground with dry pack concrete rammed tightly in place.

3.2 REMOVAL OF SHORING SYSTEMS

A. Remove shoring under the control of the Contractor's Shoring Design Engineer and the Contractor's Excavation Engineer. Advise the Engineer prior to removal.

B. Coordinate with the construction and fill and backfill programs.

C. Ensure that the retained soil remains fully supported throughout.

D. Remove shoring materials from the site after removal.

E. Any shoring to be stay-in the ground shall be pre-approved by the Owner and the Consultant. Cut and remove at least 1.5 m below grade any buried shoring members or as directed by the Consultant.

3.3 FIELD QUALITY CONTROL

A. Monitor and keep a written record of any deflections of the excavation shoring system.

B. The Contractor shall monitor excavation support systems weekly. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support systems remain stable and nearby structures and substructures remain unaffected.

END OF SECTION

PART 1. GENERAL

1.1 DESCRIPTION OF WORK

A. Work under this scope also includes supply and placing of direct buried identifiers.

1.2 RELATED SECTIONS

A. Section 01061 – Environmental Considerations.

B. Section 02140 – Dewatering.

C. Section 02723 – Granular Base and Sub-Base.

D. Section 03300 – Cast-In-Place Concrete.

1.3 REFERENCES

A. Occupational Health & Safety Act and Regulations for Construction Projects.

B. Construction Safety Association of Ontario, Trenching Safety – Introduction to Trenching Hazards, 1999.

C. CAN/CSA-A23.1, Concrete Materials and Methods of Concrete Construction.

D. CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.

E. Ontario Provincial Standard Specifications (OPSS):

1. OPSS 501, Compacting.
2. OPSS 401, Trenching, Backfilling and Compacting.
3. OPSS 1010, Aggregates-Base, Subbase, Select Subgrade and Backfill Material.
4. OPSS 1359, Unshrinkable Backfill.

F. American Society for Testing and Materials International (ASTM):

1. ASTM C117, “Standard Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing”.

2. ASTM C136, "Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates".

3. ASTM D422, latest revision, "Standard Test Method for Particle-Size Analysis of Soils".

4. ASTM D698, latest revision, "Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort".

5. ASTM D4253, latest revision, "Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table".

G. Guidance on Sampling and Analytical Method for Use at Contaminated Sites in Ontario (MOECC, Dec. 1996).

H. Transportation of Dangerous Goods Act.

1.4 DEFINITIONS

A. Common Excavation: Excavation of materials of whatever nature, including dense tills, hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy hydraulic excavating equipment.

B. Topsoil: Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

C. Waste Material: Excavated material unsuitable for use in work or surplus to requirements.

D. Borrow Material: Material obtained from locations outside area to be graded and required for construction of fill areas or for other portions of work.

E. Unsuitable Materials:

1. Weak and compressible materials under excavated areas.

2. Frost susceptible materials under excavated areas.

3. Frost Susceptible Materials:

a. Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.1.

b. Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

F. Unshrinkable Fill: Very weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches and capable of being readily excavated.

G. Construction Rubble: Excess material resulting from demolition or removal of structures, services, roads, curbs and sidewalks. Construction Rubble includes such items as concrete, reinforcing steel, asphaltic concrete, brick and granular road base, curbs, sidewalk and base materials; material which has been placed as engineered fill is not classified as Construction Rubble.

H. Reusable Fill: Soil excavated from the Site which meets the Standards for [Industrial/Commercial] Land Use, as specified in Table [3] of the "Soil, Groundwater and Sediment Standards for Use Under Part XV.l of the Environmental Protection Act" published by the Ministry of Environment (MOECC), Ontario (2009), and other environmental regulations. [Written approval must be obtained from the receiver for fill intended for placement off-site].

I. Imported Fill: Fill imported to use on site which meets the standards presented in Table 1 of the “Soil, Groundwater and Sediment Standards for Use Under Part XV.l of the Environmental Protection Act", published by the MOECC (2009). Imported fill is to be free of organics, topsoil and deleterious material such as construction rubble.

J. Excess Material: Excess soil materials resulting from construction related activities on site, may include impacted soils defined as waste, or reusable fill that can be used on-site or off-site.

K. Topsoil: Surface soil that supports plant life containing considerable organic matter.

L. Waste: Soil material which neither meets the criterion for reusable fill given above, nor is classified as construction rubble, or topsoil. Solid waste materials are classified as waste for disposal purposes depending on the results of Toxicity Characteristic Leaching Procedure (TCLP) carried out in accordance with the Ontario Environmental Protection Act, Regulation 347 (as amended by Ontario Regulation 558), Ontario Ministry of Environment (MOECC), based on the comparison of leachate test results with Schedule 4 Criteria (Leachate Quality Criteria). Material that requires off-site disposal as directed by the Consultant, and exceeds limits set forth in Ontario Regulation 347 is defined as “Hazardous Waste”. Material that requires off-site disposal as directed by the Consultant, and does not exceed these limits, is defined as “Impacted Soil”.
With regards to PCBs, bulk concentrations over 50 ppb are considered hazardous waste (refer to the attached Tables 1, 2, and 3 for details).

M. Impacted Water: Storm water (surface water, precipitation, runoff, etc.), groundwater in the excavation area, wastewater from equipment cleaning operations from the wheel wash area, and any other water generated through site activities which does not meet the standards for All Types of Property Use as specified in Table [3] of the "Soil, Groundwater and Sediment Standards for Use Under Part XV.l of the Environmental Protection Act" published by the Ministry of Environment (MOECC), Ontario (2009), and other environmental regulations (refer to the attached Tables 4, 5, and 6 for details).

N. Impacted Zone: Areas of the site on which the presence of impacted soil and/or groundwater are identified (refer to Section 1.5).

1.5 SUBMITTALS

A. Submit Shop Drawings for temporary shoring design and erection in accordance with Section 02150 – Bracing and Shoring.

B. Unless noted otherwise, within 30 calendar days of date of Award of Contract and as agreed to by the Consultant, submit for the Consultant's review a set of Comprehensive Dewatering Controls and Methods Plan(s) (CDCMP) for all disciplines identified in this section covering the detailed requirements and monitoring requirements in the Contract Documents and Geotechnical Data Report.

C. Shop Drawings will include material grades, core thicknesses, connections, joints, method of anchorage, number of anchors, supports, details and accessories.

D. Ensure Shop Drawings are of uniform size and based on field measurements.

E. Shop Drawings shall bear the stamp of a Professional Engineer licensed to practice in the Province of Ontario.

F. The Consultant's review of the Shop Drawings will be for general review purpose, and it will not be reviewed for structural strength design, the responsibility for which shall remain with the shoring designer whose stamp appears on the Shop Drawings.

G. Work is to be submitted one (1) week before excavation.

1.6 SAMPLES

A. Submit samples in accordance with Section 02150 – Bracing and Shoring.

B. Inform the Consultant prior to commencing work, of proposed source of fill materials and provide access for sampling.

1.7 PROTECTION OF EXISTING FEATURES

A. Existing Buried Utilities and Structures:

1. Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

B. Prior to commencing excavation work, notify Consultant or authorities having jurisdiction, establish location and state of use of buried utilities and structures.

Authorities having jurisdiction shall clearly mark such locations to prevent disturbance during work.

C. Confirm locations of buried utilities by careful test excavations.

D. Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of the Consultant before moving or otherwise disturbing utilities or structures.

E. Record location of maintained, re-routed and abandoned underground lines.

1.8 PROJECT CONDITIONS

A. Geotechnical Conditions:

1. The Contractor is responsible for carrying out any investigation necessary to ensure that the requirements of the Contract are fulfilled in accordance with these Specifications and as shown on the Contract Drawings. The Contractor shall inform the Consultant of any intention to carry out such investigations.

B. Relics and Antiquities:

1. Upon discovery report immediately to the Consultant. All resulting activity due to such a discovery will be considered a Contract Change by the Consultant. The Consultant will issue instructions as to their disposal and afford the Owner an opportunity to recover such articles.

2. All relics, antiquities, coins, fossils or other articles of value or interest which are uncovered during the excavation and backfilling work or discovered elsewhere on Site are the property of the Owner.

PART 2. PRODUCTS

2.1 MATERIALS

A. Granular Base: To Section 02723 – Granular Base and Sub-Base.

B. Granular Sub-Base: To Section 02723 – Granular Base and Sub-Base.

C. Fill Concrete: To Section 03300 – Cast-In-Place Concrete and following requirements:

1. Minimum compressive strength at 28 days: 15 Mpa.

2. Slump at time and point of discharge: 100 mm.

3. Unshrinkable Fill: To OPSS 1359 and Section 03300 – Cast-In-Place Concrete and the following requirements:

a. Minimum compression strength at 7 days: 0.5 MPa.

D. Native Backfill:

1. Selected material from excavation approved by the Consultant for use intended, unfrozen and free from rocks larger than 150 mm, cinders, ashes, sods, refuse or other deleterious materials.

E. Pipe Bedding:

1. Shall be Granular A material conforming to OPSS 1010 and OPSS 401, placed beneath and above pipe in accordance with the Contract Documents. Gradation to be within the limits specified when tested to ASTM C136 and ASTM C117.

F. Rigid Perimeter Insulation:

1. Expanded polystyrene to CAN/ULC-S701 or approved equivalent, thickness as shown on Drawings.

G. Embankment Materials Require Approval by the Consultant:

1. Material used for embankment not to contain organic matter, frozen lumps, weeds, sod, roots, logs, stumps or any other unsuitable material.

H. Warning Tape:

1. Warning tape shall be made of polyethylene, and provided for use for each of the following categories:

a. "CAUTION", 3 mm thick, 76.2 mm wide tape, yellow with black letters.

b. "CAUTION BURIED CABLE TV LINE BELOW", 4 mm thick, 76.2 mm wide, orange with black letters.

c. "CAUTION BURIED OIL LINE BELOW", 5 mm thick, 152.4 mm wide, orange with black letters.

d. "CAUTION BURIED FIBER OPTIC LINE BELOW", 4 mm thick, 76.2 mm wide, orange with black letters.

e. "CAUTION BURIED GAS LINE BELOW", 4 mm thick, 76.2 mm wider, yellow with black letters.

f. "CAUTION BURIED HIGH VOLTAGE CABLE BELOW", 5 mm thick, 76.2 mm wide, red with black letters.

g. "CAUTION BURIED ELECTRIC LINE BELOW", 4 mm thick, 152.4 mm wide, red with black letters.

h. "CAUTION BURIED RECLAIMED WATER LINE BELOW", 5 mm thick, 50.8 mm wide, purple with black letters.

2. 1000% elongation properties on roll lengths of a minimum or 1800 m.

2.2 COMPACTION EQUIPMENT

A. Compaction equipment must be capable of obtaining required densities in materials on project.

B. Compaction equipment must not overload existing structures or utilities or new work.

C. Compaction equipment not specified herein is to be efficiency proved at no extra cost and written approval must be received from Consultant before use.

2.3 QUALITY ASSURANCE

A. Testing:

1. Compaction testing will be performed by testing agency (in the presence of the Consultant) on a regular basis during backfilling and compacting operations. The Contractor will be required to provide heavy machinery and operators for subgrade proof-rolling, at no cost to the Owner. Afford the testing time, space and facilities for performing these tests. In the event that poorly graded material has been placed or has been improperly compacted, or the subgrade has been improperly compacted, the Owner's Representative/Consultant reserves the right to require the removal of as much of the material as deemed necessary and to have

the area recompacted after replacement of suitable acceptable material at no cost to the Owner. In addition, the Contractor may be required to excavate test pits of varying depths to allow the Consultant to carry out additional tests at no cost to the Owner.

2. Unshrinkable fill materials will be tested by the Consultant for conformance to OPSS 1359.

3. Cooperate with and assist the Consultant during inspections and tests.

4. Remove defective materials and completed work which fails tests and replace as directed by Consultant at no cost to the Owner.

5. Where work or materials fail to meet strength requirements and/or quality as indicated by test results, pay costs of additional inspection and testing required for new replacement work or materials.

6. Perform any additional testing by a testing laboratory acceptable to the Consultant, at no cost to the Owner.

B. Source Approval:

1. Inform Consultant of proposed source of aggregates and imported fill and provide access for sampling and testing of quality of material at least four (4) weeks prior to commencing production.

2. Source of materials to be incorporated into work or stockpiled requires Consultant's approval.

3. Submit geotechnical laboratory test results for samples of specified fill to be supplied by this Section. Submit with proposed source of imported fill (Select Fill), analytical chemistry analysis of representative samples of the fill that determine the concentrations of the chemical parameters contained in Table 1 of the "Soil, Groundwater and Sediment Standards for Use Under Part XV.l of the Environmental Protection Act".

4. If, in the opinion of the Consultant, materials from the proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that the material from the source in question can be processed to meet specified requirements at no cost to the Owner.

5. Should a change of materials source be proposed during work, advise Consultant two (2) weeks in advance of proposed change to allow sampling and testing.

6. Acceptance of a material at source does not preclude future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unsatisfactory. Removal and disposal of all rejected material shall be at the Contractor's expense.

C. Production Sampling:

1. Products shall be subject to continual sampling by the Consultant during production.
2. Provide the Consultant with ready access to source and processed material for purpose of sampling and testing.
3. If materials fail to meet Specifications, bear the cost of additional sampling and testing of aggregates.
4. Provide the necessary personnel and equipment to permit adequate investigation and sampling. Advise the Consultant at least two (2) weeks in advance of the use of any material, to allow sufficient time for sampling and testing.
5. Final acceptance of materials will only be made after the materials have been dumped, spread and compacted in place. Rejection by the Consultant can be made at the source, on the transportation vehicle or in place. Removal and disposal of rejected material shall be at the Contractor's expense.

PART 3. EXECUTION

3.1 PREPARATIONS AND LAYOUT

A. Establish extent of excavation.

B. Set out all lines and levels as indicated in Contract Documents or as directed by the Consultant required for proper excavation.

C. Maintain benchmarks, monuments and other reference points. Re-establish if disturbed or destroyed at no additional cost to the Owner.

3.2 LINES AND ELEVATIONS

A. Establish lines and elevations from Control Points shown on Contract Drawings.

B. Have lines and elevations established by a Land Surveyor or Engineer licensed to practice in the Province of Ontario.

C. Protect and maintain Control Points and Bench Marks as long as they are required.

3.3 SITE PREPARATION

A. Remove obstructions; ice and snow, from surfaces to be excavated within limits indicated.

B. Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.4 ENVIRONMENTAL REQUIREMENTS

A. Protect and repair exposed excavations where required to prevent adverse effects of rain, freezing weather and other weather conditions on subgrade of subsequent.

B. Suspend construction operation at times when satisfactory results cannot be obtained on account of rain, snow, freezing weather or other unsatisfactory conditions.

C. Do not carry out filling or backfilling in freezing weather unless authorized by the Consultant. Do not use frozen material nor place material where the material in place is already frozen.

D. Dust control shall be applied by the Contractor as required and/or when directed to do so by the Consultant or Authorities having jurisdiction.

3.5 UTILITIES

A. Prior to commencement of excavation work, establish location and extent of all underground utilities occurring in work area. Inform Consultant immediately of any discrepancy from the information regarding utilities in the Drawings provided.

B. Maintain, re-route or extend as required existing utility lines which pass through work area, and which must remain. Pay all costs for this work except costs borne by utility companies.

C. Protect utility services uncovered by excavation.

D. Remove abandoned utility service lines encountered from areas of construction. Cap, plug or seal such lines and identify at grade with markers.

E. Accurately locate and record abandoned and active utility line re-routed or extended on As-Built Drawings as per Section 01330 – Submittals.

3.6 SALVAGE MATERIAL

A. Remove and dispose of water, abandoned gas and sewer pipes, valves, valve boxes and fittings, maintenance holes, frames and covers and other material which may be encountered in the excavation.

3.7 STRIPPING OF TOPSOIL

A. Strip topsoil from the excavation and embankment areas and from areas as indicated on the Drawings or as directed by the Consultant after vegetation has been removed from these areas.

B. Strip topsoil to its full depth. Do not mix topsoil with subsoil.

C. Stockpile in locations as directed by the Consultant. Stockpile height not to exceed 2 m.

D. Dispose of unused topsoil as directed by the Consultant.

3.8 STOCKPILING

A. Stockpile fill materials in areas designated by the Consultant. Stockpile granular materials in manner to prevent segregation.

B. Protect fill materials from contamination.

3.9 TRENCHING AND EXCAVATION

A. Excavate to lines, grades, locations, elevations and dimensions as indicated or directed by the Consultant.

B. Excavation to be kept to a minimum allowing for safe and stable excavation slopes. Slopes which in the opinion of the Consultant are not safe shall be rectified at the Contractor's expense.

C. Remove excavated material and other obstructions encountered during excavation.

D. Excavation must not interfere with normal 45° splay of bearing from bottom of any footing.

E. Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

F. The bottom of footings, for the foundations, shall be cleared of any debris and approved by the Consultant prior to pouring the concrete footings. Remove unsuitable material from trench or excavation bottom to extent and depth as directed by the Consultant.

G. For trench excavation, unless otherwise authorized by the Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

H. All suitable materials from the excavations shall be used in the fill areas; however, all materials not incorporated into the work shall be hauled off site and disposed of at the Contractor's expense.

I. When the subgrade in a cut is considered unsuitable by the Consultant, the material shall be removed to a depth he designates and replaced with granular material.

J. All surplus excavated material shall be disposed of by the Contractor from the property under their own arrangements, but in compliance with all regulating agencies. It is to be assumed that excavated material will be re-used on site for backfill only along the north and south walls.

K. After the excavation has been completed, all foundation beds to be examined by, and meet with the approval of the Consultant. Foundation beds shall be thoroughly tamped to solidify the bearing surface of the ground, without extra charge.

L. All work shall be maintained in a well drained condition at all times.

M. Do not obstruct flow of surface drainage or natural watercourses.

N. Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.

O. Notify the Consultant when bottom of excavation is reached.

P. Obtain the Consultant's approval of completed excavation.

Q. Correct unauthorized over-excavation as follows:

1. Fill under bearing surfaces and footings with concrete specified for footings.
2. Fill under other areas with Granular 'B' material specified in Section 02723 – Granular Base and Sub-Base.

R. Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of the Consultant.

3.10 FILL TYPES AND COMPACTION

A. Use fill of types and compaction densities as approved by Consultant.

3.11 CORRECTION FOR OVER EXCAVATION

A. Correct unauthorized excavation at no extra cost as follows:

1. Fill under bearing surfaces and footings with concrete specified for footings.
2. Fill to sub-base for slab with Granular 'A' (Type 1) fill compacted to 100% Standard Proctor maximum dry density.
3. Fill around foundation walls with Granular 'A' (Type 2) fill compacted to 100% Standard Proctor Density.
4. Other areas as recommended by the Consultant.

3.12 PROOF ROLLING OF SUBGRADE

A. Proof roll subgrade using standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four (4) tires arranged abreast with centre to centre spacing of 730 mm.

B. If use of nonstandard proof rolling equipment is approved, Geotechnical Engineer to determine level of proof rolling.

C. Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

D. Where proof rolling reveals areas of defective subgrade reconstruct the defective work and repeat proof rolling.

3.13 EXCAVATED MATERIAL DISPOSAL

A. Remove excess excavated material from the site, except material approved by the Consultant to be reused, at appropriate on-site locations. Protect stockpiles of material to be reused against moisture absorption.

B. Where soil contains construction rubble, roots or organic materials, separate the soil from the rubble, roots or organic material by sieving or other approved means.

C. Results of soil testing are provided in the geotechnical documents. Carry out any further testing that is required, as a condition of disposal, by the operators of the disposal sites at no cost to the Owner.

D. Store excess soil in a lugger box until tested. Lugger box to be placed in a location designated by the Owner's Representative and be clear of traffic.

E. Dispose of excess soil in lugger box as directed by the Consultant. Carry out any testing that is required, as a condition of disposal, by the operators of the disposal sites at no additional cost to the Owner.

F. Excess Material:

1. The excess soil and fill material shall be disposed of at a MOECC approved soil treatment site, waste disposal site or any other appropriate disposal site meeting applicable regulations for excess soil and fill material disposal. Identify and propose an offsite disposal option or disposal facility meeting all applicable and current regulations for excess soil and fill material disposal.

2. Obtain all necessary permits, licences, registrations and manifests required to transport and dispose materials from site to disposal facilities and provide copies of these to the Consultant.

3. Prior approval of the offsite disposal option and facility by the Consultant is required. Provide the operator's name, location, business address, the type of licence under which the site operates or certificate of approval, the criteria used by the site to assess the suitability of the excess material for disposal and all necessary details and documentation of the offsite disposal site to the Owner's Representative for review and approval. No material shall be removed for offsite disposal without the approval of the disposal site or receiving facility. Contractor is responsible for obtaining all regulatory approvals, permits and any other requirements for offsite disposal. This includes requirements for all additional testing, such as any chemical analysis required by the current MOECC Guideline and Ontario Regulation 347. Include cost of all approvals, permits, testing and analysis.

4. If excess material is to be provided as cover material for MOECC approved landfill sites, be responsible for completing the required analytical testing for confirming with the landfill operators the quantity of excess material that they will accept, and the rate at which they will accept it along with any other requirements. The location and quantity of the material suitable as a cover material should be identified and other details provided to the Consultant. The address of the landfill or waste disposal site which will accept the material along with necessary documentation from the site operators should be provided to the Consultant for approval.

5. If there is any visual or other indication that a waste material is encountered, immediately inform the Consultant. Material suspected of being a waste shall be handled and managed in accordance with applicable regulations and stockpiled or stored in lugger boxes on site to allow further testing by the Consultant. Chemical test results obtained by the Consultant will be provided.

6. Submit to the Owner's Representative, within 48 hours of a load of excess soil or other material leaving the site, waybills or other documentation recording the time and place of disposal of that load of excess soil or other material.

7. All reasonable measures must be taken to minimize the quantity of soil and other materials disposed of as waste.

8. Where the Contractor's operations change the nature of excavated material which would otherwise have been classified as reusable fill, such that it has to be disposed of as a waste, payment for disposal shall be made as if excavated material met the criteria for reusable fill.

9. Soil and other materials shall be disposed of as waste if unacceptable for reuse. Reusable fill for on-site use is subject to the application of the MOECC Guidelines and other environmental regulations. The application of the guidelines and chemical quality of the material are subject to interpretation based on site specific conditions. As such, no soil material will be handled or considered as a waste unless it is necessary to manage it as waste in accordance with environmental regulations and guidelines.

G. Topsoil:

1. Topsoil shall be stockpiled on site for reuse.

3.14 HYDRO-EXCAVATION (VACUUM TRUCK)

A. In areas indicated on the Drawings or as directed by the Consultant, excavation shall be performed by means of hydro-vac truck only.

B. Excavate to lines, grades, locations, elevations and dimensions as indicated or directed by the Consultant.

C. Remove excavated material and other obstructions encountered during excavation.

D. Excavation must not interfere with normal 45° splay of bearing from bottom of any footing or from the bottom of any tie of an in-service railroad track.

E. Do not disturb soil within branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.

F. For trench excavation, unless otherwise authorized by the Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.

G. Dispose of excavated material offsite.

H. Do not obstruct flow of surface drainage or natural watercourses.

I. Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.

J. Notify the Consultant when bottom of excavation is reached.

K. Remove unsuitable material from trench bottom to extent and depth as directed by the Consultant.

L. Correct unauthorized over-excavation as follows:

1. Fill under bearing surfaces and footings with concrete specified for footings.

2. Fill under other areas with Granular 'B' Type II material specified in Section 02723 – Granular Base and Sub-Base.

3. Hand trim, make firm and remove loose material and debris from excavations.

4. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil. Clean out rock seams and fill with concrete mortar or grout to approval of the Consultant.

3.15 BACKFILLING

A. Do not proceed with backfilling operations until Consultant has inspected and approved installations.

B. Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.

C. Do not use backfill material which is frozen or contains ice, snow or debris.

D. Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.

E. Backfill Around Installations:

1. Place bedding and surround material as specified elsewhere or as a minimum as follows:

   a. Place and compact indicated granular bedding material for bedding underground services, piping, cables, structures, etc. to a minimum thickness of 150 mm; and

   b. Place and compact indicated granular material around pipes to a minimum thickness of 300 mm above top of pipe, in accordance with the Contract Drawings and details.

2. Do not backfill around or over Cast-In-Place Concrete within 24 hours after placing of concrete.

3. Place layers simultaneously on both sides of installed work to equalize loading. Difference not to exceed 0.3 m.

4. Where temporary unbalanced earth pressures are liable to develop on walls or other structures:

a. Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Consultant, or

b. If approved by Consultant, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Consultant.

F. Where indicated on Drawings, install insulation as per Drawings, using adhesive as recommended by the Insulation Manufacturer.

3.16 COMPACTION

A. Compaction densities are determined by ASTM D698. Water can be added if necessary to obtain required densities. Correct irregularities or depressions that may develop during compaction by removing or adding material to form a smooth and uniform surface.

B. Compact backfill materials to the following minimum densities:

1. Select Fill: 98*%* maximum dry density.
2. Granular "A": 100% maximum dry density.
3. Granular "B": 100% maximum dry density.
4. Sand Fill: 100% maximum dry density.
5. 19 mm Crusher-Run Limestone: 100% maximum dry density.

C. Compact 19 mm Clear Crushed Limestone and Pea Gravel with three (3) passes of a vibratory plate.

D. Ensure compaction operations do not cause vibration and noise levels to exceed acceptable limits as per jurisdictional authorities.

E. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

F. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to the Consultant.

G. Field compaction testing procedures by Consultant on general backfill:

1. Each layer of backfill will be divided into lots with maximum area of 4000 m^2 or entire area being compacted at one time, whichever is smaller. Each lot will be divided up into four (4) equal sublots and one in situ density and moisture test will be carried out at selected locations within each sublot.

2. Each sublot density will be expressed as percentage of target density calculated to nearest 0.1%. Average percent compaction and range of percent compaction of four tests will be computed and rounded to nearest 0.1%.

3. Quality index (Q_i) for completed lot will be calculated as follows:

   a. $Q_i = \frac{x-95}{R}$ where:

   b. Q = Quality index (computed to two decimal points).

   c. x = Arithmetic mean of four tests within a lot, expressed as percent of target density (mean).

   d. R = Difference between largest and smallest value of four tests within a lot expressed in percent compaction (range).

4. Lot will be accepted if range does not exceed 15 percent and where Q_i has a positive value equal to or greater than 0.66.

5. Where Q_i is below value of 0.66 or range exceeds 15 percent, lot will be rejected, and further compaction and/or adjustment of moisture content will be required.

H. Field compaction testing by the Consultant on other backfill will be on basis of direct comparison of individual in situ density tests with target density.

I. Where compaction does not conform to acceptance compact as necessary to meet acceptance criteria.

3.17 SUPPLYING AND APPLYING WATER

A. The Contractor shall be required to provide water to reduce dust nuisance and to maintain correct moisture content in the granular material where required by the Consultant.

3.18 INSPECTION & TESTING

A. Testing of materials and compaction will be carried out by testing laboratory designated by the Consultant. Frequency of tests will be determined by the Consultant.

B. Representative samples of all materials shall be taken by the Consultant and submitted to laboratory tests for approval of its quality and nature prior and/or during its use in the work. The Contractor shall provide the necessary personnel and equipment to permit adequate investigation and sampling and shall advise the Consultant at least one week in advance of the use of any material to allow sufficient time for sampling and testing.

C. Representative locations in the compacted materials shall be tested in-situ. The Contractor shall provide the necessary access for the testing personnel.

D. Final acceptance of materials will only be made after the materials have been dumped, spread and compacted in place. Rejection by the Consultant may be made at the source, on the transportation vehicle or in place. Removal and disposal of all rejected material shall be at the Contractor's expense.

3.19 RESTORATION

A. Upon completion of work, remove waste materials and debris, trim slopes, and correct defects as directed by Consultant.

B. Replace topsoil as directed by the Consultant.

C. Reinstate pavement and sidewalks, lawns to elevation which existed before excavation.

D. Clean and reinstate areas affected by work as directed by the Consultant.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Division 1 – General Requirements.

B. Section 02315 – Excavating, Trenching and Backfilling.

C. Section 02723 – Granular Base and Sub-Base.

D. Section 02733 – Forcemains.

1.2 REFERENCES

A. ASTM D4791, Test Method for Flat or Elongated Particles in Coarse Aggregate.

1.3 SAMPLES

A. Submit samples in accordance with Section 01330 – Submittals.

B. Allow continual sampling by the Engineer during production.

C. Provide the Engineer with access to source and processed material for sampling.

D. Pay cost of sampling and testing of aggregates that fail to meet specified requirements.

1.4 MEASUREMENT AND PAYMENT

A. Work outlined in this Section is included in the Lump Sum Tender Price.

PART 2. PRODUCTS

2.1 MATERIALS

A. Ensure that Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.

B. Flat and Elongated Particles of Coarse Aggregate: To ASTM D4791.

1. Greatest dimension to exceed four times least dimension.

C. Fine aggregates satisfying requirements of applicable section to be one, or blend of following:

1. Natural sand.

2. Manufactured sand.

3. Screenings produced in crushing of quarried rock, boulders, gravel or slag.

D. Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:

1. Crushed rock.

2. Gravel and crushed gravel composed of naturally formed particles of stone.

3. Light weight aggregate, including slag and expanded shale.

2.2 SOURCE QUALITY CONTROL

A. Inform the Engineer of proposed source of aggregates and provide access for sampling at least ten (10) working days prior to commencing production.

B. If, in opinion of the Engineer, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.

C. Advise the Engineer ten (10) working days in advance of proposed change of material source.

D. Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

PART 3. EXECUTION – NOT APPLICABLE

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 02701 – Aggregates – General.

1.2 REFERENCES

A. ASTM C117, Test Method for Material Finer than 0.075 mm Sieve in Mineral Aggregates by Washing.

B. ASTM C131, Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

C. ASTM C136, Method for Sieve Analysis for Fine and Coarse Aggregates.

D. ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)(2,700 kN-m/m^3).

E. ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)(2,700 kN-m/m^3).

F. ASTM D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

G. ASTM D4318, Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

H. CAN/CGSB-8.1, Sieves Testing, Woven Wire, Inch Series.

I. CAN/CGSB-8.2, Sieves Testing, Woven Wire, Metric.

1.3 DELIVERY, STORAGE AND HANDLING

A. Deliver and stockpile aggregates in accordance with Section 02701 – Aggregates – General. Stockpile minimum 50% of total aggregate required prior to commencing operation.

1. Store cement in weather tight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.

PART 2. PRODUCTS

2.1 MATERIALS

A. For Granular Base and Granular Sub-Base Materials to Section 02701 – Aggregates – General and following requirements:

1. Gradations to be within limits specified when tested to ASTM C1 136 and ASTM 117. Sieve sizes to CAN/CGSB-8.1.

B. Other Properties as follows:

1. Liquid Limit: To ASTM D 4318, maximum 25.

2. Plasticity Index: To ASTM D 4318, maximum 6.

3. Los Angeles Degradation: To ASTM C 131. Max percent loss by weight: 45.

4. Crushed Particles: At least 60% of particles by mass within each of the following sieve designation ranges to have at least one freshly fractured face. Material to be divided into ranges using methods of ASTM C136.

C. Soaked CBR: To ASTM D1883, minimum 100, when compacted to 100% of ASTM D1557.

PART 3. EXECUTION

3.1 SEQUENCE OF OPERATION

A. Place granular base after the sub-base surface is inspected and approved by the Engineer.

B. Placing of Granular Base:

1. Construct granular base to depth and grade in areas indicated.

2. Ensure no frozen material is placed.

3. Place material only on clean unfrozen surface, free from snow and ice.

4. Place material using methods which do not lead to segregation of degradation of aggregates.

5. Place material to full width in uniform layers not exceeding 150 mm compacted thickness.

6. Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

7. Remove and replace that portion of layer in which material becomes segregated or unsuitable during spreading.

C. Compaction Equipment:

1. Compaction equipment to be capable of obtaining required material densities.

D. Compacting:

1. Compact to density not less than 100% Standard Proctor Maximum Dry Density in accordance with ASTM D698.

2. Shape and roll alternately to obtain smooth, even and uniformly compacted base.

3. Apply water as necessary during compacting to obtain specified density.

4. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Engineer.

5. Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

6. Conform to the compaction requirements as specified in the City of Greater Sudbury's Standard Drawings.

E. Proof Rolling:

1. For proof rolling use standard roller of 45,400 kg gross mass with four (4) pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four (4) tires arranged abreast with centre to centre spacing of 730 mm.

2. Obtain approval from the Engineer to use non-standard proof rolling equipment.

3. Proof roll at level in granular base as indicated. If use of non-standard proof rolling equipment is approved, the Engineer is to determine level of proof rolling.

4. Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

5. Where proof rolling reveals areas of defective subgrade:

a. Remove base, sub-base and subgrade material to depth and extent as directed by the Engineer.

b. Replace base material and compact in accordance with this Section.

c. Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by the Engineer and replace with new materials in accordance with this Section at no extra cost.

3.2 PLACING

A. Place granular sub-base after sub-grade is inspected and approved by the Engineer.

B. Construct granular sub-base to depths and grade in areas indicated.

C. Ensure no frozen material is placed.

D. Place material only on clean unfrozen surface, free from snow or ice.

E. Place granular sub-base materials using methods which do not lead to segregation or degradation.

F. For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.

G. Place material to full width in uniform layers not exceeding 150 mm compacted thickness.

H. Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

I. Remove and replace portion of layer in which material has become segregated or unsuitable during spreading.

3.3 COMPACTION

A. Compaction equipment to be capable of obtaining required material densities.

B. Compact to density of not less than 98% Standard Proctor Maximum Dry Density (SPMDD) in accordance with ASTM D698.

C. Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.

D. Apply water as necessary during compaction to obtain specified density.

E. In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Engineer.

F. Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

G. Conform to the minimum compaction requirements as specified in the City of Greater Sudbury Standard Drawings.

3.4 PROOF ROLLING

A. Proof rolling shall be used in pavement areas.

B. For proof rolling use standard roller of 45,400 kg gross mass with four (4) pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four (4) tires arranged abreast with centre to centre spacing of 730 mm maximum.

C. Obtain approval from the Engineer to use non-standard proof rolling equipment.

D. Proof roll at level in sub-base as indicated. If non-standard proof rolling equipment is approved, the Engineer is to determine level of proof rolling.

E. Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

F. Where proof rolling reveals areas of defective subgrade:

1. Remove sub-base and subgrade material to depth and extent as directed by the Engineer.

2. Backfill excavated subgrade with approved common material and compact in accordance with this Section.

G. If proof rolling is carried out on the granular sub-base, if it reveals areas of defective sub-base, remove and replace in accordance with this Section at no extra cost.

3.5 SITE TOLERANCES

A. Finished base and sub-base surface to be within plus or minus 5 mm of established grade and cross section but not uniformly high or low.

3.6 PROTECTION

A. Maintain finished base and sub-base in condition conforming to this Section until succeeding material is applied or until acceptance by the Engineer.

END OF SECTION

PART 1. GENERAL

1.1 GENERAL

A. All conditions of the Contract apply to the work in this Section.

1.2 SCOPE OF WORK

A. This Section covers the supply and installation of sewage and sludge forcemains and buried piping systems carrying fluid under pressure called for or implied by the Drawings and Specifications, together with all necessary incidentals whether referred to or not, as will be required to complete the work to the full intent and meaning of the Drawings and Specifications. The work includes, but is not limited to:

1. Addition of isolating valve to the existing forcemain.

B. The piping specified herein extends up to the first flexible joint adjacent to each structure or building where applicable.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01400 – Quality Requirements.

B. Section 01501 – Suggested Construction Sequencing.

C. Section 02315 – Excavating, Trenching and Backfilling.

D. Section 03300 – Cast-In-Place Concrete.

E. Section 11100 – Piping, Valves and Fittings.

1.4 DEFINITIONS

A. Bedding:

1. Material used to support pipe below and up to spring line for all pipes except PVC which shall be supported to top of pipe.

B. Cover Material:

1. Material placed from top of bedding to a minimum distance of 300 mm above outside top of pipe.

1.5 PROTECTION AGAINST FLOATION

A. Prevent damage to any pipeline due to hydrostatic pressure during construction and until completion of work.

1.6 COLD WEATHER WORK

A. Protect all work from freezing.

B. Do not lay pipes on frozen ground.

1.7 MEASUREMENT AND PAYMENT

A. The Lump Sum Price stated in the Form of Tender for the forcemains shall cover compensation in full for supplying all equipment, labour and materials and constructing the forcemains and appurtenances complete as shown on the Drawings and as specified herein. It is the responsibility of this Section to connect this piping to the piping systems specified in Section 11100 and to existing forcemain as shown on the Drawings.

B. Forcemain swabbing will be paid as a provisional item as described in the Form of Tender.

PART 2. PRODUCTS

2.1 PIPE MATERIAL

A. Supply pipes in size and class as shown on Contract Drawings.

B. Supply pipe of material selected under Contract.

C. Supply fittings suitable for, and compatible with, class and type of pipe with which they will be used and as approved by the Engineer.

2.2 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Supply and install PVC water pipe and fittings as shown on the Drawings of the sizes and dimension ratios/classes indicated thereon and according to the Specifications herein.

B. PVC pipe shall conform to the following requirements:

1. Manufacturer: CSA-B137.3, ASTM D1784.

2. Sizes: 100 mm to 300 mm shall meet the requirements of AWWA C900 Class 150.

3. Joints: Bell and Spigot Type Joints with Rubber Gaskets to ASTM D3139.

4. Fittings: Cast or Ductile Iron to AWWA C110.

5. The pipe to be supplied shall be certified by the CSA.

6. PVC pipe shall be Manufactured by Atlantic Industries, Canron Pipe, Rehan Industries Inc., Royal Pipe Limited or Scepter Manufacturing Co. Limited.

2.3 DUCTILE IRON PIPE:

A. Supply and install DI pipe and fittings as shown on the Drawings of the sizes and dimension ratios/classes indicated thereon and according to the Specifications herein.

B. DI pipe shall conform to the following requirements:

1. AWWA C151 Ductile Iron Pipe.

2. Minimum Wall Thickness for Pipe with Mechanical and Push-On Joints to be Class 52.

3. Minimum Wall Thickness for Pipe with Flanged Joint or Plain End and Victaulic Coupling to be Class 53.

4. Joints – ANSI A21.11 (AWWA C111) Rubber Gasket Mechanical or Push-On Joints.

5. Fittings – ANSI A21.10 (AWWA C110) Gray Iron Fittings.

6. Fitting Joints – ANSI A21.11 (AWWA C111) Rubber Gasket Mechanical Joints.

7. Flanges – ANSI B16.1, Class 150.

8. Inside Lining – All Pipes and Fittings to be Cement-Mortar Lined and Seal Coated in accordance with ANSI A21.4 (AWWA C104).

9. The outside coating shall be a Petroleum Asphaltic Coating approximately 1 mil (25 μm) thick.

10. Polyethylene Encasement to ANSI A21.5 (AWWA C105).

11. Acceptable Suppliers:

    a. Canada Pipe Company.

    b. Canron.

2.4 STAINLESS STEEL PIPING AND FITTINGS

A. Stainless steel pipe that is buried shall be Schedule 40S conforming to ANSI B36-19. The pipes that are buried in concrete shall be USS Gauge 8.

B. Fittings shall be of the same schedule as the piping and shall be butt welding type conforming to ANSI B16.9 and MSS SP-43.

C. Flanges shall be stainless steel slip on, lap joint or weld neck type with flat faces conforming to ANSI B16.1 Class 150.

D. Victaulic joints as specified elsewhere in this Section may be used to connect buried piping runs exceeding 6 m in length.

2.5 COUPLINGS

A. Supply and install couplings of the Dresser Style 40 or reviewed equivalent as shown on the Drawings.

B. Where different types of pipe materials are connected together, supply and install transition couplings of the Dresser Style 162 or reviewed equivalent.

2.6 RESTRAINED JOINTS AND THRUST BLOCKS

A. Thrust restraint shall be by means of concrete thrust blocks. Joint restrainers may only be used where in the opinion of the Consulting Engineer concrete is impractical. All buried metallic fittings shall be wrapped in Denso tape.

2.7 PIPE FITTINGS

A. All buried metallic fittings shall be wrapped in Denso tape.

2.8 PIPE ADAPTERS

A. Where different types of materials are connected together, supply and install suitable adaption pieces for the following:

1. Ductile Iron to S.S.

2.9 PIPE BEDDING MATERIALS

A. Pipe bedding materials shall be Type 1 fill according to Section 02315.

2.10 COVER MATERIALS

A. All cover materials shall be Type 1 fill according to Section 02315.

2.11 GATE VALVES

A. Valves to be Gate Valves to AWWA C500 or AWWA C509 and the following:

B. Valves to be capable of seat differential test pressure equal to design pressure and to a hydrostatic shell test pressure at least 50% in excess of design pressure.

C. Valves – 300 mm diameter and smaller:

1. To be designed for minimum cold water working pressure of 1035 kPa.

2. To be iron body, resilient seat type.

D. Shaft spindle to have O-rings or resilient materials.

E. Valves for buried installation to have mechanical or bell end as required.

F. Valves to open in a counterclockwise direction.

G. Valves to be made of:

1. Cast iron for valves 100 mm in diameter and larger.

2. Cast iron or bronze for valves less than 100 mm in diameter.

H. Provide adjustable disc top to body, fitted in shop, so disc cannot be wedged too tightly into body upon closing.

I. Bottom of gate shall not be above seat rings when gate in fully open position.

J. Bearing of gate on guides to be a length equal to at least 50% of port diameter.

K. Design guides for valves set in horizontal position to take weight of gate throughout its entire length of travel. Do not use rollers.

L. Design thrust bearing to safely develop full strength of valve spindle. Do not use bronze sleeve type for thrust bearings. Housing for thrust bearings to be fully bronze lined.

M. Valve spindle to be made of bronze or polished chrome-nickel iron to ANSI Type 431, machined all over to smooth finish, threaded with ACME or square type thread.

N. Spindle nests to be bronze Alloy A in accordance with OPSS 441.

O. Valve Operators:

1. Geared operators to consist of carburized, alloy steel spiral bevel gears with shafts operating in anti-friction bearings. Geared operators to be self-contained units, permanently lubricated and totally enclosed in an impact resistant cast iron housing (when specified).

P. Valve Box:

1. Supply and install valve boxes in locations as shown on the Contract Drawings. Valve boxes shall be in accordance with OPSS requirements for the specific installation type. Top of box to be marked as appropriate.

2.12 CONCRETE

A. Concrete for thrust blocks: to conform with Section 03300 Class "B" Type with 28 day compressive strength of 20 MPa.

PART 3. EXECUTION

3.1 TRANSPORTING, UNLOADING AND PIPE STORING

A. Remove from site and replace all pipes, specials, fittings and gaskets that are unsound or damaged.

B. Unload pipe using mechanical equipment.

C. Place materials in safe storage.

D. Follow Pipe Manufacturer's handling and storage recommendations.

3.2 TRENCHING AND BACKFILLING

A. Trenching and Backfilling shall be in accordance with Section 02315.

3.3 PIPE BEDDING

A. Place bedding materials to specified depths and widths as per details indicated on Drawings.

B. Shape bed true to line and grade, free from sags and high points.

C. Shape bedding to conform to cylindrical surface with radius conforming to outer surface of pipe in accordance with Pipe Manufacturer's recommendations.

D. Compact full width of bed to 98% Standard Proctor Maximum Dry Density.

E. Place bedding materials simultaneously on each side to springline of pipe and compact to 95% Standard Proctor Maximum Dry Density.

F. Keep pipe joints clear of bedding materials to permit jointing. After jointing is complete, place bedding materials as specified.

G. Concrete bedding may be placed in two (2) lifts provided:

1. Level of first is not higher than 75 mm above bottom of pipe.

2. First lift is cured 24 hours minimum before placing second lift.

H. Prevent movement of pipe during placement of concrete bedding.

I. Place bond breaking agent between concrete bedding and sheathing.

3.4 INSTALLATION OF PIPES

A. Lay pipes on prepared bed, true to line and grade as shown on Contract Drawings.

B. Ensure that barrel of each pipe is in contact with shaped bed throughout its full length.

C. Ensure that ends of pipe abut against each other so that there is no unevenness along inside.

D. Lower pipe into trench carefully.

E. Keep ends of pipe clean.

F. Do not exceed permissible deflection at joints as recommended by Pipe Supplier.

G. Do not lay pipe on frozen bedding.

H. Handle pipe with special care during temperatures below freezing.

I. Keep pipe clean as work progresses. Do not allow water to flow through pipe during construction.

J. Keep trench dry and do not lay pipe in water.

K. Whenever work is suspended, install a removable watertight bulkhead at open end of last pipe laid.

L. Do not lay pipe until preceding pipe joint has been completed and pipe is carefully embedded and secured in place.

3.5 JOINTING GENERAL

A. Clean joint surfaces.

B. Lay pipes on prepared bed, true to line and grade as shown on Contract Drawings.

C. Lubricate pipe ends with material recommended by Pipe Manufacturer.

D. Follow Manufacturer's instructions in jointing pipes.

E. Keep pipe parallel to previously laid pipe. Sling pipe only at centre.

F. Pull or push pipe only by hand or power operated winch. Do not use backhoe for pushing pipe.

G. Prevent joints from opening after pipe has been laid.

3.6 PLACING COVER MATERIAL

A. Place cover materials from pipe bedding to 300 mm above top of pipe.

B. Place cover materials in uniform layers as per Manufacturer's Specification for equipment used.

C. Compact each layer to 95% Standard Proctor Maximum Dry Density.

D. Provide 300 mm layer of cover material above pipe before using mechanical compactor on top of pipe.

3.7 CUTTING OF PIPE

A. Whenever cutting of pipe is required, cut pipes as recommended by Pipe Manufacturer.

B. Method of cutting and cutting equipment to be subject to approval of Consulting Engineer.

3.8 THRUST RESTRAINT

A. Protect all connections, caps and bends that are liable to "Draw" or blow-off by means of concrete blocking, tie rods, bell-bolted or harness joints as specified.

B. Place concrete for thrust blocks against undisturbed ground making sure joints and couplings are free from concrete.

3.9 HYDROSTATIC TESTING

A. Perform hydrostatic and leakage test on forcemains in conformance with OPSS 412, Section 412.07.17.

3.10 CLEANING AND FLUSHING

A. Perform cleaning and flushing of forcemains in accordance with ASTM E1575.

B. Forcemain swabbing shall be performed with incrementally larger swab sizes starting with a swab no larger than 0.5 times the original inside pipe diameter. Success will be measured by the passing of a swab greater than or equal to the diameter of the forcemain being cleaned.

3.11 TRACER WIRE

A. According to Contract Notes on the Drawings.

3.12 PIPE INSULATION

A. Apply pipe insulation according to Contract Notes on the Drawings and wherever the cover over the pipe is less than 1.8 m and as specified.

B. Insulation shall be done in accordance with the Contract Notes on the Drawings.

END OF SECTION

DIVISION 3

CONCRETE

INDEX

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 01330 – Submittals.

B. Section 03420 – Precast Concrete Chambers.

C. Section 05550 – Anchorage in Concrete and Masonry.

1.2 INTENT OF SECTION

A. Section covers Cast-In-Place Concrete work including:

1. Formwork and Falsework.
2. Reinforcing.
3. Waterstops.
4. Joints.
5. Setting of Anchor Bolts and Inserts.
6. Concrete Mixes, including High Performance Concrete.
7. Concrete Placing.
8. Watertightness Test.
9. Finishing.
10. Curing.
11. Protection.
12. Quality Assurance.
13. Encasements and Concrete Fill.
14. Concrete Work for Other Trades and Co-ordination between Trades.
15. Grouting.

16. Modifications to Existing Concrete Structures.

17. Concrete Repairs.

1.3 STANDARDS

A. Comply with the following Statutes, Codes and Standards, and all amendments thereto:

1. The Ontario Building Code (OBC 2012) and National Building Code (NBC 2020).

2. Canadian Standards Association (CSA):

   a. A23.1, Concrete Materials and Methods of Concrete Construction.

   b. A23.2, Test Methods and Standard Practice for Concrete.

   c. A23.3, Design of Concrete Structures.

   d. A3001, Cementitious Materials for Use in Concrete.

   e. A3002, Masonry and Mortar Cement.

   f. S269.2-M, Access Scaffolding for Construction Purposes.

   g. S269.3-M, Concrete Formwork.

3. American Concrete Institute (ACI):

   a. ACI 304.2R, Placing Concrete by Pumping Methods.

   b. ACI 350M, Code Requirements for Environmental Engineering Concrete Structures and Commentary.

   c. ACI 350.1-10, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.

   d. 347R-14, Guide to Formwork for Concrete.

   e. 214R-11, Recommended Practice for Evaluation of Compression Test Results of Concrete.

4. American Society for Testing and Materials International (ASTM):

   a. C260, Standard Specifications for Air-Entraining Admixtures for Concrete.

   b. C494/C494M, Standard Specifications for Chemical Admixtures for Concrete.

   c. C900-14, Standard Test Method for Pullout Strength of Hardened Concrete.

d. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

5. National Lumber Grades Authority (NLGA):

a. Standard Grading Rules for Canadian Lumber.

1.4 PAYMENT

A. Concrete work will be valued for payment in accordance with the following schedule, subject to any applicable holdbacks:

1. 30 percent at completion of casting.

2. 50 percent at completion of curing.

3. 20 percent at completion of finishing.

1.5 CERTIFICATION OF MATERIALS AND CONCRETE PRODUCER

A. Submit to the Consultant for review the following information:

1. Statements identifying the sources and certifying that:

a. Aggregates comply with CSA-A23.1 and are from MTO Designated Sources; submit gradations.

b. Materials, plant and equipment to be used in concrete work comply with the requirements of CSA-A23.1.

c. The concrete supplier is a certified member of the Ready-Mix Concrete Association of Ontario (RMCAO).

d. Calculations showing the standard deviation for the Concrete Producer in conformance with ACI 214.

1.6 CONCRETE DESIGN MIXES

A. Concrete Mix Designs:

1. Submit proposed performance mix design data, and the Supplier's applicable standard deviations.

2. Tabulate Concrete Mixes: Indicate the types of cement, size of coarse aggregate, compressive strength, water/cementing material ratio, admixtures used, air content, slump and the locations of use for each mix.

3. For high slump flowing concrete submit a mix that will not result in segregation.

4. Concrete mix designs will be reviewed for conformance with the requirements of the Specifications and will be returned with the Consultant's comments.

1.7 TRIAL MIXES

A. Undertake trial mixes of each structural concrete mix design.

B. Undertake trial mix testing well prior to the start of on-site concrete construction, to allow time for evaluation and any necessary modifications.

C. Submit test results from trial mixes at the same time as the mix designs, confirming workability, linear shrinkage, Chloride Ion Penetrability and concrete strength.

D. Adjust mixes that do not provide adequate performance, and re-test.

1.8 REGULAR CONFIRMATION OF LINEAR SHRINKAGE PERFORMANCE OF MIXES

A. Repeat linear shrinkage testing of each structural concrete mix every three months, utilizing the current sources of materials and mix designs. Confirm appropriate re-testing dates and mixes to be included with the Consultant prior to re-testing.

B. Submit test results from repeat tests confirming linear shrinkage performance within 40 days of casting the specimens.

C. Adjust mixes that do not provide adequate performance, and re-test.

1.9 TESTING OF CONCRETE

A. Testing will be performed by a testing agency arranged by the Consultant/Owner.

B. To Facilitate Testing Services:

1. Furnish such casual labour as is necessary to obtain and handle samples at the project and at the sources of materials.

2. General Contractor provides and maintain facilities for storing and initial curing of test cylinders and provide suitable crates for shipping test cylinders.

3. Provide and maintain for the use only of the testing agency, facilities conforming to CSA-A23.1 and CSA-A23.2 acceptable to the agency for storing and curing of test cylinders.

4. Advise the testing agency sufficiently in advance of the operation to allow for the desired quality tests and for the assignment of personnel.

C. Routine testing of materials and resulting concrete for compliance with the technical requirements of the Specifications, will be paid for by the Owner.

D. Engage the testing agency and pay costs associated with testing required because of changes in materials or proportions of the mix requested by the Contractor, and extra testing of concrete or materials occasioned by their failure to meet the Specification requirements.

E. The use of testing services does not relieve the Contractor of their responsibility to furnish materials and construction in compliance with the Contract Documents.

1.10 DRYING SHRINKAGE TESTS (ONLY FOR WATERTIGHT STRUCTURES)

A. Drying Shrinkage Tests:

1. Perform laboratory trial mixes of concrete used on the Contract. Make two (2) sets of three (3) specimens for each shrinkage test.

2. Prism Specimen Size: 100 mm by 100 mm by approximately 285 mm with an effective gauge length of 250 mm.

3. Specimens: Fabricate, cure, dry and measure as specified in ASTM C157 and modified as follows:

    a. Remove specimens from molds aged 23 hours, ± 1 hour after trial batching.

    b. Place immediately in water at 22.8 degrees Celsius ± 2 degrees Celsius for at least 30 minutes.

    c. Measure within 30 minutes thereafter to determine the original length and then submerge in saturated limewater at 22.8 degrees Celsius, ± 2 degrees Celsius.

    d. Measure specimens at age seven (7) days to determine expansion expressed as percentage of the original length. Length at age seven (7) days shall be the base length for drying shrinkage calculations (0 days drying age).

    e. Store specimens immediately in a humidity control room maintained at 22.8 degrees Celsius, ± 2 degrees Celsius and 50 percent, ± 4 percent relative humidity for the remainder of the test.

    f. Measure to determine shrinkage expressed as percentage of base length and report separately for 7, 14, 21, and 28 days of drying after seven (7) days of moist curing.

B. Computing drying shrinkage deformation of each specimen:

1. Difference between the base length (at 0 days-drying age) and the length after drying at each test age.

2. Compute average drying shrinkage deformation to the nearest 0.001 percent at each test age.

3. If drying shrinkage of any specimen departs from the average of that test age by more than 0.04 percent, disregard the results obtained from that specimen.

C. Maximum allowable concrete shrinkage at 28 day drying age:

1. 0.040 percent maximum for laboratory trial mixes of proposed concrete.

2. If shrinkage specimen tests for concrete exceed the shrinkage limits, modify the concrete mix to reduce shrinkage. Repeat tests with the new mix.

1.11 FORMWORK AND FALSEWORK

A. Design formwork and falsework in accordance with CSA-S269.2-M, and S269.3-M and CSA-A23.1. Formwork type to provide the specified finishes.

B. Design formwork and falsework to carry dead loads and construction live loads.

C. When a high range water reducer (superplasticizer) is used in concrete mix, design forms for the full hydrostatic pressure.

D. Make joints in forms watertight.

E. Design formwork to meet variations from the reference system specified in CSA-A23.1 and as specified herein.

1.12 PRE-CONCRETE CONFERENCE

A. Prior to concrete construction hold a meeting to review the procedures for producing proper concrete construction.

B. Have responsible representatives of every party who is concerned with producing quality concrete work attend the conference, including but not limited to the following:

1. Contractor's Superintendent.

2. Concrete Subcontractor's Foreman and Cement Finisher.

3. Concrete Floor Finishing Subcontractor.

4. Ready-Mix Concrete Producer.
5. Admixture Manufacturer(s).
6. Laboratory responsible for the Concrete Design Mixes and Trial Mixes.
7. Concrete Pumping Equipment Supplier.
8. Laboratory responsible for Field Quality Control.

C. Provide a description of the intended procedures and Quality Assurance for:

1. Concrete mix production, delivery, and discharge.
2. Formwork construction and alignment.
3. Concrete handling, pumping, and placement.
4. Concrete finishing.
5. Concrete curing.
6. Concrete protection in hot, cold, or windy weather.

D. Ensure that each party's interests are discussed, and procedures refined to provide optimum concreting practices for this project.

E. The Owner and Consultant will attend the conference. Coordinate with the Consultant at least ten (10) days prior to the scheduled date of the conference.

F. Distribute minutes of the meeting to all parties present and/or concerned within five (5) days of the meeting.

G. Ensure that procedures established and agreed at this meeting are carried out during construction.

H. If additional procedures are required, meet again, discuss, develop, submit and follow agreed procedures.

1.13 CONCRETE SLAB FINISHING QUALITY ASSURANCE

A. Concrete Slab Finish Subcontractor shall be a Member in good standing with the Concrete Floor Contractors Association of Canada.

B. Concrete Finishers: Skilled personnel with a minimum of five (5) years of proven satisfactory experience finishing concrete of a comparable size and scope.

C. Engage the Manufacturers' Representative for on Site Supervision prior to, during, and after applications. Verify that the specified products are correctly applied and that the amount and finishing procedures comply with the Manufacturer's printed instructions for the Contract.

D. Conference prior to slab placement:

1. Conducted by the Contractor.

2. Conference Agenda:

   a. Concrete mix design.

   b. Placing techniques.

   c. Finishing techniques.

   d. Product application procedures.

   e. Equipment required for the procedures.

3. Attendees:

   a. Contractor's Superintendent.

   b. Subcontractor's Representative involved in installation and finishing.

   c. Consultant/Owner.

1.14 CO-ORDINATION

A. Openings, bases, anchorage and similar items sized on the Contract Drawings for mechanical, process and electrical equipment specified are for tendering purposes only.

B. Adjust the work to suit the actual equipment being supplied. Verify all sizes with the trade supplying and installing the equipment. Obtain, utilize and submit data on relevant sizes to suit any change in equipment. Confirm the adjustments with the Consultant.

C. Coordinate the supply and installation of the Structural Precast Concrete:

1. Assist in the installation and alignment of the units.

2. Assist in the position of the rebar, dowels and waterstops.

3. Complete the expansion and construction joints, the sealing and the grouting at the cast in place walls.

1.15 SUBMITTALS

A. Submittals in accordance with Section 01330 – Submittals.

B. Review Submittals.

C. Shop Drawings:

1. Prepare and submit Shop and Layout Drawings, as necessary for construction or as requested by the Consultant.

2. Review Shop Drawings prior to submission. Assume responsibility for confirming and correlating quantities and dimensions, selecting fabrication processes and techniques of construction, and coordinating the work of all trades.

3. Highlight every change made from the Contract Documents.

4. Do not commence work in items covered by Shop Drawings before the Consultant has reviewed the Drawings.

5. The Consultant will review the Drawings only to check conformance with the design concept of the project. Reviewed Drawings will be returned marked 'Reviewed', 'Reviewed as Noted', or 'Revise and Resubmit'.

6. Review of Shop Drawings does not relieve the Contractor from compliance with requirements of the Contract Drawings and Specifications nor relieve him of responsibility for errors made in the Shop Drawings.

D. Concrete Mix Designs and Trial Mix Results:

1. Submit as noted above.

E. Concrete Placing Schedule:

1. Submit concrete placing schedule.

2. Detail layout of construction joints.

F. Shop and Erection Drawings for Formwork and Falsework:

1. Submit Formwork and Falsework Drawings.

2. Show design loads and material Specifications.

3. Show layout and dimensions of construction joints in the structure.

4. Show materials and layout of panels for formwork.

5. Show seal and signature of a Professional Engineer, licensed in the jurisdiction of the construction, responsible for the formwork and falsework design and inspection during construction.

6. Formwork and falsework Shop Drawings will not be reviewed for structural adequacy.

7. Submit Manufacturer's Product Data Sheets including materials, allowable loading, installation, application and maintenance instructions for products and materials used in the falsework and formwork, and for form ties.

G. Reinforcement Placing Drawings and Bar Lists:

1. Submit Reinforcement Placing Drawings and Bar Lists.

2. On placing Drawings, indicate sizes, spacing, location and quantities of reinforcement and mechanical splices with identifying code marks to permit correct placement without reference to Structural Drawings. Indicate lengths of laps and show layout of construction joints. Indicate sizes, spacing and location of chairs, spacers and hangers. Do Drawings in accordance with Reinforcing Steel Manual of Standard Practice – by Reinforcing Steel Institute of Canada.

3. Bar lists may be used as reference but will not be reviewed or stamped.

4. Submit Shop Drawings of dowel bar splicers detailing the locations, size and type.

H. Shop Drawings for Joints:

1. Joints Construction:

a. Submit detailed Shop Drawings of each joint type. Submit an elevation or section taken through the plane of the joint showing the walls and slabs at the joint.

2. PVC Waterstops:

a. Submit details of the waterstop system, sizes, types, splices, method of securing and supporting the waterstop to maintain proper orientation and location during concrete placement.

3. Details of joint fillers, sealant, adhesives, and other appurtenances.

I. Samples for Joint Materials:

1. Submit samples of:

a. Regular bulb and large bulb PVC waterstops, waterstop splices, joints, and fabricated crosses and tees of each size, shape, and fitting of waterstop(s).

2. Joint fillers and their adhesives

J. Product Data Sheets for Joint Materials:

1. Submit Manufacturer's Product Data Sheets including installation, application, and maintenance instructions for the following items (as applicable):

a. PVC waterstops.

b. Hydrophilic waterstops.

c. Preformed joint filler.

d. Adhesive for joint filler and adhesive for rebar dowels.

K. Winter Protection Systems:

1. Submit written descriptions of proposed methods of providing appropriate concreting conditions, and preventing cold weather damage together with Drawings or Sketches for:

a. Subgrades prior to placing concrete.

b. Freshly placed concrete being cured.

c. Completed structures and parts of structures subject to frost or ice damage.

d. Anchorages being installed into existing concrete and gaining strength.

e. Concrete being cast against existing concrete.

2. Await approval of protective measures before placing concrete.

L. Hot Weather Protection Schemes:

1. Submit written descriptions of proposed methods of providing appropriate concreting conditions, and preventing hot weather damage together with Drawings or Sketches for:

a. Concrete in the truck.

b. Freshly placed concrete.

c. Completed structures and parts of structures subject to heating damage.

d. Anchorages being installed into existing concrete and gaining strength.

e. Concrete being cast against existing concrete.

1.16 STANDAR DETAILS

A. For standard details refer to Contract Drawings.

B. A standard Concrete Pour Release Form is appended to this Section.

PART 2. PRODUCTS

2.1 MATERIALS FOR CONCRETE MIXES

A. Use materials conforming to CSA-A23.1.

B. Cement:

1. Normal Portland Cement (Type GU) Blended with Cementitious Hydraulic Slag (Type S) for all classes of exposure except C1 exposure. Portland Cement (Type HS or HSb) Blended with Cementitious Hydraulic Slag (Type S) for C1 exposure. Use cements conforming to CSA-A3001.

2. Comply to the following conditions and requirements:

   a. For structural concrete mixes, use slag as a replacement for 20 percent to 35 percent by mass of the quantity of cement.

   b. For lean concrete slag is not acceptable.

C. Aggregates:

1. From MTO approved designated sources.

2. Fine Aggregate – natural sand to CSA-A23.1.

3. Coarse Aggregate – gravel or crushed stone to CSA-A23.1.

D. Additives:

1. Conform to CSA-A23.1.

2. Water Reducing Agents:

   a. Superplasticizer (Plant Added).

   b. Mid-Range Water Reducers.

   c. Normal Rate – Water Reducing Agent.

3. Air-Entraining Agents:

    a. Use except in skim slabs, fill concrete and Class N exposure mixes.

4. Ensure admixtures are compatible with each other and with construction materials used in contact with concrete.

5. Do not use calcium chloride nor admixtures containing chlorides.

E. Water: Use only potable water.

F. Do not use materials that are toxic in their installed condition. Do not use volatile organic compounds where not permitted by law. Where the use of volatile organic compounds is permitted, provide adequate ventilation and take all necessary safety precautions.

2.2 CONCRETE MIXES

A. Proportion concrete for structures to create high-performance concrete, with improved durability, reduced shrinkage and reduced cracking.

B. Proportion in accordance with CSA-A23.1:

1. Concrete Compressive Strengths: See Table below (2.2.D).

2. Linear Shrinkage:

    a. Limit linear shrinkage to 0.040 percent after 28 days drying.

    b. All high-performance concrete mixes are subject to linear shrinkage tests.

3. Density:

    a. Normal density.

4. Durability Design Life:

    a. The pumping station facility to be upgraded and will be kept in continuous service. Provide concrete produced under this Section with an expected design life of at least 70 years for the service conditions defined by the usage, and the exposures specified in the Contract Documents.

C. General:

1. Establish the proportions of cementing materials, aggregates, water, and admixtures required to produce consistent, workable concrete that is watertight, durable concrete with the strength and other properties specified in the Contract Documents.

2. Comply with CSA-A23.1 for Volume Stability Considerations.

3. Provide mixes that meet the most stringent requirements of each of the exposures as specified in CSA-A23.1.

4. Use the same types and brand of cement throughout the Contract.

5. Comply with and allow for the supplier's Standard Deviation as specified in CSA-A23.1 for Compressive Strength Requirements.

D. Mixes for Normal density High-Performance Concrete:

Note: For all C1 exposure mixes the Chloride ion penetrability test shall be less than 1500 coulombs within 91 days.

1.	High-Performance concrete for structural slabs, beams and reinforced slabs on grade (with reduced shrinkage, reduced cracking, and increased durability).	Class C1 exposure. 35 MPa at 56 days Max. W/C=0.40.	Maximum Coarse Aggregate Size – 20 mm.
2.	Concrete for benching, duct banks and pipe encasements.	Class C1 exposures. 35 MPa at 56 days.	Maximum Coarse Aggregate Size – 20 mm.
3.	Concrete for site structures, curbs, sidewalks and approach slabs.	Class C1 exposure 35 MPa at 56 days Max. W/C=0.40.	Maximum Coarse Aggregate Size – 20 mm.
4.	Concrete for fill concrete, skim slabs, underpinning and, pipe bedding.	Class N exposure 20 MPa at 28 days.	Maximum Coarse Aggregate Size – 20 mm Self-Consolidating Concrete (SCC).
5.	Precast concrete structures (chambers).	Class C1 exposures. 35 MPa at 56 days.	Performance mix to precast concrete Manufacturer.

2.3 REINFORCEMENT

A. Reinforcement – Deformed billet steel bars complying with CSA-G30.18-M92, Grade 400R.

B. Welded wire mesh – Comply with ASTM A1064.

C. Chairs:

1. Use only approved bar supports of strong, durable and non-corrodible materials that fasten or tie securely to the reinforcement and strictly adhere to specified concrete cover requirements.

2. Precast concrete blocks with tie wires or dowels, cast-in, especially made for this purpose. Do not use broken or chipped blocks.

3. Do not use masonry brick or concrete block as rebar chairs.

D. Mechanical Reinforcement Splices:

1. Provide threaded couplers with a minimum tensile capacity of 125 percent of the bar yield strength only where shown.

2. Conform to CSA-A23.3.

3. Acceptable products are:

   a. Dayton Richmond Dowel Bar Splicer.

   b. Acrow Richmond Dowel Bar Splicer.

   c. Bar-Lock Lock Shear Bolt Coupling Sleeves by Bar-Lock (MBT) Coupler Systems.

   d. Lenton Couplers by Erico Products Inc.

4. Provide a thread in plastic plug to protect the threads.

5. Clip the mounting washer, if provided, to maintain cover without displacing the bar.

2.4 ACCESSORIES

A. Anchor Bolts:

1. Anchor Bolts – ASTM F1554 quality.

2. Stainless Steel – Alloy 304 or 316, as indicated on the Drawings.

B. Joints:

1. PVC Waterstop:

   a. Arctic Grade PVC waterstop conforming to Ontario Hydro Specification No. M-264 to the sizes noted on Drawing.

   b. Use sizes as shown on the Standard Details.

c. Provide factory made Tee's, Crosses, and laterals for all interconnections. Field welding of tees and laterals is not acceptable.

d. Have the Manufacturer clearly print his name, the product name and the place of Manufacture in 6 mm high (minimum) letters of a contrasting colour on the waterstop repeating every 3 m or less along its length.

e. Submit certified test results prepared by an Independent Testing Company to indicate conformity to the standard specified in (1) above.

f. Testing will be undertaken periodically by the Owner to confirm the quality and consistency of the material.

2. Cold Joint Waterstops:

a. Hydrotite CJK-0725, or larger, & RSSK 080P, 1006P, or larger hydrophilic rubber waterstops and Leakmaster Hydrophilic Caulking by MME Multiurethanes. Install all hydrophilic waterstop with adhesive and mechanical fasters (galvanized nails) with steel mesh as per Manufacturer recommendation.

b. Use in joints between existing and new concrete, around pipes through concrete, precast concrete and mounting frames, in conjunction with steel waterstops, or where future removal is planned.

3. Joint Filler:

a. Foam/Cork:

i. Rodofoam PR with Rodofast Adhesive by Sternson.

ii. Cermar by W. R. Meadows.

iii. Cork by W.R. Meadows.

b. Rope:

i. With diameter 50 percent larger than joint width.

ii. Ethafoam by Dow Chemical.

iii. Backer Rod by Acrew Richmond.

4. Sealant at isolation two-component polysulphide sealant applied according to the Manufacturer's instructions or recommendations:

a. Duoflex by Sika.

b. Primer – as recommended by Sealant Manufacturer.

c. Bond Breaker – an inert film such as polyethylene sheet or masking tape.

5. Materials used in joints – compatible with each other and with the concrete.

C. Drill-In Anchors/Rebar:

1. HILTI HY200 / Hilti HIT-RE500 V3 Adhesive Fastening System or Hilti Ice Adhesive Fastening System.

2. Type 316 Stainless Steel HILTI HIT ROD.

3. 400 Grade Reinforcement for Rebar Dowels.

D. Non-Shrink Grout:

1. Sika Grout 212 by Sika.

2. In-Pakt Precision Grout by King.

3. NC Grout Eucclid Chemical Company.

E. Epoxy Grout:

1. Sikadur 35, Hi-Mod LV by Sika Inc.

2. Brutem 19 by BASF Chenney.

3. Talygrout 100 by Sika.

2.5 FORMWORK

A. Use plastic coated plywood forms for surfaces required to have a Class 1 and 2 finish. Use full sheets, if possible, with a minimum of filler pieces. Use forms a maximum of 5 times, to the approval of the Consultant. Remove and replace rejected areas or panels.

B. Use plywood or steel forms for surfaces required to have a Class 3 or 4 finish.

C. Where different classes of finish are required to different areas of the same surface, extend the formwork for the Class 1 or 2 areas 1.2 m into the Class 3 or 4 areas.

D. Remove and replace any pieces of formwork rejected by the Consultant.

E. Form 20 mm x 20 mm fillets and chamfers at all corners and concrete edges.

F. In water/earth retaining structures use only water-tight types of formwork ties and spacers. Do not use formwork ties or spacers that leave holes through the concrete and require grouting of the holes later.

G. The Contractor may propose alternative type of formwork when using formliner for Consultant's approval.

2.6 GROUT FOR BASES, ANCHORS, EQUIPMENT MOUNTING, PIPE OPENINGS IN WALLS

A. Use proprietary non-shrink grout (min. 40MPa) ('INPAKT' by C.C. Chemicals, Embeco 636 by Master Builders, M-Bed Standard by Sternson Ltd.) as approved by the Consultant. Where grout is of such a nature as to cause discoloration or staining on exposure, leave it 25 mm shy of the finished surface and purge with cement mortar to match the surrounding material.

2.7 MORTARS

A. Sika Repair 223 by Sika Canada.

B. Emaco R300 by Master Builders.

C. Associated bonding agents as recommended by the Manufacturer.

D. Or approved equal mortar product.

PART 3. EXECUTION

3.1 STANDAR OF WORKMANSHIP

A. Comply with CSA-A23.1 'Concrete Materials and Methods of Concrete Construction'.

B. Undertake all aspects of the work to meet watertight requirements.

C. Have the formwork designer inspect forms before use to ensure conformity with the design.

3.2 CO-ORDINATION

A. Determine the requirements of other trades, inform concerned trades and assume responsibility for location, installation and quality of all items which affect the work of this Section.

B. Have all box-outs, inserts and form ties placed in the formwork before reinforcing steel is placed. Divert reinforcement around inserts and box-outs as shown on the standard detail. Do not allow other trades to cut reinforcing steel to clear inserts.

C. Examine existing construction. Determine accurate dimensions of existing construction. Where the Work involves modification of, and/or connections to, the existing structures, the dimensions shown on the Drawings are taken from the original Design Drawings and variations may exist.

D. Adjust the Work to fit existing construction. Advise the Consultant of the adjustments and obtain acceptance. Record the adjustments on the Construction Record Drawing Set.

3.3 RELEASES

A. Obtain the Consultant's release for:

1. Rebar reinforcement, formwork and inserts as placed.

2. To commence placing of concrete.

B. Provide notice of intent to pour between 24 hours and seven (7) days prior to the pour.

C. Provide a completed Concrete Pour Release Form (appended) prior to each pour and allow the Consultant two (2) hours for his inspection.

D. Do not order concrete until the Concrete Pour Release Form has been signed by the Consultant.

3.4 TOLERANCES FOR CONCRETE

A. Variation from Level or Plumb:

1. For wall, slab, beam, concrete pad and column surfaces:

   a. In 3 m – plus or minus 6 mm.

   b. In any storey or bay or 6 m max. – plus or minus 10 mm.

2. For exposed corners, lines and tops of walls:

   a. In any storey or bay or 6 m max. – plus or minus 6 mm.

B. Variation from a reference system and general dimensions:

1. less than 2.4 m – + 5 mm.

2. 2.4 m to 9.6 m – + 12 mm.

3. 9.6 m to 14.4 m – + 20 mm.

4. over 14.4 m – + 25 mm.

C. Variation in size and location of sleeves and openings – plus or minus 6 mm.

D. Variation in cross-sectional dimensions of columns, beams and in the thickness of slabs, concrete pad and walls:

1. Minus – minus 6 mm.

2. Plus – plus 13 mm.

3. Maximum step or offset in wall surface or underside of slab surface in Class 1 areas – 1.5 mm.

E. Variation in size and location of hardware and other embedded items:

1. 3 mm c/c of any bolts within an anchor bolt group or groups.

2. 5 mm from the centre of any anchor bolt group or other embedded items to established layout line dimension.

F. Variation in Steps:

1. A flight of stairs:

a. Rise – plus or minus 3 mm.

b. Tread – plus or minus 6 mm.

2. In consecutive steps:

a. Rise – plus or minus 1.5 mm.

b. Tread – plus or minus 3 mm.

3.5 FORM SURFACE PREPARATION

A. Remove water, snow, ice, laitance, curing compound, loose soil and other debris.

B. Thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt and other surface contaminants prior to coating the surface.

C. Examine the form face on any form proposed for re-use. Remove and replace any damaged sections.

D. Exposed Wood Forms in Contact with Concrete: Apply a form release agent as recommended by the Manufacturer.

3.6 ASSEMBLY AND ERECTION OF FORMS

A. General:

1. Conform with the submitted designs.

2. Unless specified otherwise in the Contract Documents, follow the applicable recommendations of CSA-S269.2-M and S269.3-M.

3. Align form joints and make watertight. Keep the number of joints to a minimum.

4. Laterally brace formwork and falsework and prevent displacement during concrete placement.

5. Form chases, openings, projections, recesses, expansion joints and construction joints.

6. Form around pipes, mechanical, and electrical equipment which penetrate the concrete structure.

7. Incorporate frames, castings, pipes, sleeves, and similar items into the formwork.

8. Do not re-use damaged formwork which may not provide a uniform, consistent finish.

9. Do not use forms more than a maximum of five (5) times.

B. Beveled Edges (Chamfer):

1. Form 15 mm bevels at concrete edges, unless shown otherwise on the Drawings.

2. Where beveled edges on existing adjacent structures are other than 15 mm, obtain the Consultant's approval of the size prior to placement of the beveled edge.

C. Wall Forms:

1. Locate form ties and joints in an uninterrupted uniform pattern.

2. Inspect form surfaces prior to installation to ensure conformance with the specified tolerances.

3. Do not use through-the-wall removable form ties for walls of liquid holding structures and exterior walls which are below grade.

4. Joint Filler Attachment:

a. Use attachments to secure premolded joint filler to one side only.

b. Secure premolded joint filler without gaps and separations keeping concrete from the second wall pour from penetrating the thickness and space occupied by the premolded joint filler. Seal all premolded joint filler joints by taping.

c. Do not use form ties, or other devices which permanently penetrate premolded joint filler, or produce a rigid connection between pours.

3.7 CONCRETE MIX DESIGN AND QUALITY ASSURANCE

A. Supply concrete to meet the project requirements. Structural Concrete is generally required to be "High Performance Concrete" for increased durability and reduced shrinkage and cracking, compared to regular structural concrete. Adjust poorly performing concrete mixes to meet the project requirements. Adjust concrete mixes to provide improved performance with less cementitious materials if the opportunity identified below is available. Provide changes to the mix proportions required, or for improved performance with less cementitious materials. Follow the requirements outlined below.

B. Prepare concrete mix designs in accordance with the specified requirements. Proportion to provide concrete with enhanced durability, and reduced shrinkage and cracking.

C. Ensure excellent handling, placing and finishing characteristics.

D. Undertake laboratory testing to confirm the suitability and performance of the mixes. Provide concrete standard test, consisting of 4 cylinders, for each 50 m^3 of concrete of each type placed in any day. For remaining concrete or if the amount placed for each type/area of concrete, is less than 50 m^3, provide one set of 4 cylinders for strength test as verified by the Consultant on site. Respectively, one cylinder at seven (7) days, two cylinders at 28 days and one cylinder at 56 days will be tested. The Owner may test the concrete on site for linear shrinkage. Provide concrete, initial curing facilities, and casual labour for these tests.

E. Submit proposed mix designs and test mix results.

F. After review of the mix designs, supply concrete in accordance with the reviewed mixes.

G. Monitor the performance of each concrete mix as work proceeds. Where performance remains appropriate maintain the mix proportions and continue the monitoring. Where performance is less than desired or acceptable, propose and test revised mixes to improve performance or correct deficiencies. Submit proposed revised mixes and laboratory test results for review.

3.8 TOLERANCES

A. Rebar Tolerances:

1. Straight bars – plus or minus 25 mm.
2. Stirrups, ties or spirals – plus or minus 13 mm.
3. Bent bars – length – plus or minus 25 mm.
4. Truss bar height – plus 0 mm to minus 13 mm.
5. Where increases cause interference with waterstop – plus 0 mm.

B. Concrete Placing Tolerance:

1. Concrete protection of reinforcement – + 8 mm.
2. Place steel to the tolerance given in the table below related to the depth of a flexural member, the thickness of a wall, or the smallest dimension of a column:
    a. Member Dimension Tolerance.
    b. Less than or equal to 300 mm – + 8 mm.
    c. 300 mm to 600 mm – + 12 mm.
    d. greater than or equal to 600 mm – + 20 mm.
3. Lateral Spacing – + 30 mm.
4. Longitudinal Location:
    a. Bends and Ends of Bars – + 50 mm.
    b. Bends and Ends of Bars at discontinuous ends of members – + 20 mm.

3.9 DEVELOPMENT FOR REINFORCEMENT

A. Splice reinforcement as per the standard details shown on the Drawings, unless otherwise noted.

B. Hook reinforcement as per the standard details shown on the Drawings, unless otherwise noted.

C. Where reinforcement laps between construction joints, stagger laps. Lap no more than 50 percent of bars at one point.

3.10 ANOCHOR BOLTS

A. Make anchor bolts conform to the standard anchor bolt details shown on the Contract Drawings.

3.11 CONSTRUCTION JOINTS

A. Make construction joints conform to the standard details shown on the Drawings unless otherwise indicated.

B. Fabricate waterstop in accordance with the Manufacturer's recommendations. Provide welded joints to make a continuous ribbed barrier to water. Provide waterstop to all construction joints and to other joints as shown.

C. Leave the surface of horizontal construction joints rough with 6 mm deep ridges and valleys.

D. Blast clean joints of loose material, laitance and form oil before the next pour is made.

3.12 PREPARATION OF SURFACES

A. Remove water, snow, ice, loose soil, laitance, curing compound, wood, and other debris from surfaces on or against which new concrete will be placed.

B. Roughen and clean surfaces of previously placed concrete against which subsequent concrete will be placed.

3.13 CONCRETE BONDING

A. Horizontal Construction Joints in Reinforced Concrete Walls:

1. Thoroughly clean and saturate the surface of the joint with water.

2. For walls and columns, place bedding layer of starting concrete (mix 5) onto the existing concrete before starting regular concrete placement. Limit wall and column starting concrete placement to a maximum thickness of 150 mm and a minimum thickness of 100 mm.

3. Do not deposit concrete from pump hoses or large concrete buckets, unless the specified placement thickness can be maintained and verified through inspection windows close to the joint.

4. Limit concrete placed immediately on top of slurry concrete to 300 mm of thickness. Thoroughly vibrate to mix concrete and starting concrete together.

B. To Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to a roughness profile of 6 mm.

2. Saturate surface with water for 24 hours prior to placing new concrete.

3.14 SETTING ANCHOR BOLTS FOR EQUIPMENT, FITTINGS AND STRUCTURAL STEEL

A. Receive, handle, and set anchor bolts in accordance with the requirements of the Supplier. Protect anchor bolts after setting to maintain the correct alignment and level.

3.15 INSTALLATION OF ELECTRICAL CONDUITS IN SLABS AND WALLS

A. Generally, install electrical services surface mounted or in trays.

B. Only conduits providing service local to the pour that cannot be surface mounted may be installed in a concrete slab or wall:

1. Do not install conduit in exterior slabs or walls.

2. Obtain written acceptance from the Consultant prior to installation in slabs or walls.

3. Coordinate the installation of any conduit in slabs and walls with the electrical installation requirements.

4. Displace less than 1 percent of the concrete at any cross section. Space conduits a minimum of 100 mm and at least 3 diameters apart. Do not cross conduits.

5. Install conduits where allowed in slabs and walls in accordance with the requirements of CSA-A23.1 for Conduits and Pipes Embedded in Concrete.

6. Do not embed aluminum conduits in concrete.

3.16 FRAMES FOR COVERS AND OPENINGS

A. Set frames at the locations and elevations as required on the Drawings.

3.17 EQUIPMENT CASTINGS AND PIPE FITTINGS

A. Set castings and pipe fittings at the locations and elevations as required on the Drawings.

B. Repair hot-dip galvanized surfaces which are damaged by welding, cutting, handling during shipping or erection, or otherwise, in accordance with ASTM A780 using a zinc-rich coating. Dry film thickness on repairs shall exceed the original coating thickness by a minimum of 25 percent.

C. Ensure pipes passing through concrete have a waterstop or puddle flange.

3.18 EXTENT OF CONCRETE POUR

A. The horizontal limit for base slab pours is 24 m as maximum. The vertical limits for wall pours are 6 m max.

B. Break work into approximately equal units. Add waterstopped construction joints as necessary to suit pour sizes. Confirm joint location with the Consultant and adjust as necessary. Consider beams, girders, brackets, column capitals, and haunches as part of the floor or roof system above and place monolithically with the floor or roof system.

C. Allow three (3) days between pours of adjacent panels.

D. Submit details of the joint layout for review.

3.19 PLACING CONCRETE

A. General:

1. Do not commence concrete placing until sufficient manpower and equipment is available to complete the placement expeditiously preventing the formation of cold joints, and to produce the specified surface finish.

2. Provide standby equipment for critical items in case of equipment failure.

3. Verify that cast in place accessories, inserts, and reinforcement are set correctly and are not disturbed during concrete placement.

4. Place concrete on dry and clean substrate.

5. Start placing concrete for sloping slabs at the lowest point and work upwards to prevent concrete tears.

6. Place concrete within 1.0 m of its final position. In formed sections, provide sufficient elephant trunks to meet this requirement.

7. Plan placement frequency such that lift lines will not be visible in exposed or architectural concrete finishes.

B. Depositing:

1. Deposit concrete in a manner that prevents segregation in accordance with CSA-A23.1.

C. Wall and Column Grout:

1. Deposit 20 mm to 40 mm of wall and column grout evenly along horizontal construction joints in the bottom of forms through an elephant trunk immediately before placing wall or column concrete.

D. Consolidation:

1. Consolidate the concrete during and immediately after depositing, thoroughly and uniformly by means of tamping, hand tools, finishing machines, and vibrators in order to obtain dense, watertight, homogeneous concrete well bonded to reinforcing bars.

2. Carefully vibrate concrete around piping, inserts, conduits, and waterstops, to ensure thorough contact.

3. At horizontal waterstops, ensure that concrete flows under and completely fills the space below the waterstop. Verify that no air is trapped below the waterstop and that the concrete is in contact with the waterstop over its entire surface area.

4. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.

5. Do not move concrete laterally with the vibrators. Lower the vibrators vertically and vibrate within 1.0 m of the point of placement.

3.20 HOT WEATHER WORK

A. Take hot weather precautions when the concrete temperature at any time exceeds 25 degrees C.

B. Do not place concrete, whose temperature exceeds 25 degrees C. in the mixer.

C. Concrete, whose temperature in the mixer is between 25 degrees C and 30 degrees C must:

1. Contain a retarder which reduces mixing water requirements and increases strength.
2. Not contain high early strength cement.

D. Protect forms and equipment, including both mixing and placing equipment, from the rays of the sun and cool by wetting as necessary to maintain a temperature of not more than 5 degrees C in excess of ambient temperature nor more than 40 degrees C.

E. Prior to placing concrete, wet down forms and reinforcement and the area surrounding the work.

F. Keep mixing time to the minimum, consistent with the production of the quality of concrete specified and place mixed concrete immediately.

G. Use sufficient qualified personnel for rapid placing and finishing of concrete.

H. Provide wind breaks, fogging, sunshades, plastic sheeting or other materials as required by CSA-A23.1 when the evaporation is expected to exceed the limits shown.

I. Commence continuous wet curing as soon as the concrete has hardened sufficiently to prevent surface damage.

3.21 COLD WEATHER WORK

A. Take cold weather precautions whenever the ambient temperature is, or is expected to be, at or below 5 degrees C.

B. Protect subgrades below proposed concrete work. Ensure that subgrade temperatures are at least 10 degrees C when the concrete is placed.

C. Have protective measures in place, or adjacent to the work, and reviewed by the Consultant before any concrete is mixed or ordered.

D. Maintain concrete temperatures between 10 degrees C and 20 degrees C for a minimum of three (3) days for unloaded areas, and six (6) days for areas receiving partial load.

E. Where the work is enclosed, and heaters are used to provide heat:

1. Provide an access strip at least 1.0 m wide between the work and the nearest heater.

2. Do not discharge heater outlets directly toward the work.

3. Duct heater exhausts outside enclosure.

4. Install a minimum – maximum thermometer inside the enclosure at a location approved by the Consultant.

5. Maintain the humidity within the enclosure at or above 40 percent and install a suitable measuring device, or employ wet curing terminated 12 hours before the termination of heating.

F. Removal of forms, shores and protection to conform to ACI 306 for structural concrete bearing load. Remove only after tests indicate sufficient concrete strength and the release of the Consultant is obtained.

G. At the termination of the protection period, do not drop the concrete temperature more than 20 degrees C in the first 24 hours.

3.22 REMOVAL OF FORMS

A. Be responsible and utilize testing as per CSA-A23.1 before removing forms.

B. Do not remove forms without the acceptance of the Consultant.

C. The minimum length of time for forms to remain in place (unless otherwise directed by the Consultant) is:

1. Walls, columns, sides of beams, base slabs and footings	7 days
2. Floor slabs, roof slabs	7 days
3. Beam and girder soffits, shores for floor slabs and roofs	14 days

D. Have curing equipment and materials available prior to removal of the forms, install within four (4) hours and put into operation.

3.23 INITIAL PROTECTION AND CURING

A. Take special precautions to control and eliminate initial drying shrinkage and plastic shrinkage for slabs.

B. Provide wind breaks or shades. In addition, provide a continuous fog mist when drying shrinkage is likely due to heat or wind. Do not wet the concrete surface.

C. Immediately cover the concrete with wet burlap when the finishing is complete and begin the continuous wet curing.

3.24 CURING AND PROTECTION

A. Continuously wet cure concrete for a minimum of seven (7) days in accordance with CSA-A23.1. Provide the equipment necessary for the proper curing adjacent to the work before commencing pouring.

B. A curing compound may be used as an alternative to wet curing provided:

1. Finishing work is completed and the compound is compatible with the finish.

2. The rate of evaporation of surface moisture is less than 0.750 kg/(sq.m.h) as per Figure D1 of CSA-A23.1.

3. The compound is approved by the Consultant.

C. Be responsible for protection of concrete from damage by all trades. Do not pile or store materials on slabs nor wheel nor handle materials over slabs until concrete has been in place for at least seven (7) days (under normal conditions).

D. Be responsible for and provide adequate winter protection to completed or partly completed structures to prevent frost or ice damage.

3.25 FLOOR FINISHES

A. Types of finishes for the various concrete floors are shown on the Drawings.

B. The structural slab thickness shown is a minimum. Slope floors to floor drains and sump pits.

C. Do not place floor toppings in buildings until equipment is installed and mechanical and structural work is complete.

D. Where interior slabs are to bear foot traffic, provide emery shake finish.

E. Have finishing work done by an experienced floor Contractor specializing in this type of work and approved by the Consultant.

F. Details of finishes are as follows:

1. Plain Concrete:

a. Finish air entrained concrete floors or toppings (Mixes 1, 2 and 6) by screening and darbying or bull floating, followed later by two or more passes with a magnesium float and/or finishing machine, to obtain a smooth finish free of float marks. If any ridges or blemishes remain, remove them after curing with a light sanding or grinding.

b. Finish non-air entrained (interior) concrete floors or toppings (Mixes 1b, 2b and 7) by screeding, bull floating or darbying, followed later by trowelled in emery shake finish as specified below.

2. Swirl Finish on Exterior Walkways:

a. Give the surface of the concrete a non-slip swirl finish by screeding and darbying followed by final floating with a wood float.

3. Floor to Receive Quarry Tile, Resilient Flooring, Terrazzo, Screed, Grout or Bonded Topping:

    a. Strike off and screed the concrete base slab to a level below the final floor surface equal to the specified thickness of the finish coarse as shown on the Drawings.

    b. Float the surface.

    c. Wire broom the surface to make 6 mm deep grooves, running in one direction.

4. Bonded Topping, Screed or Grout:

    a. Leave the concrete floors designated to receive bonded toppings, screeds, or grouts broomed as specified in .3 above, to provide a key for the toppings applied later.

    b. Clean and soak the rough floor thoroughly with water and keep wet for a period of 24 hours, then remove the free water and give the wet surface so left a slurry of neat cement broomed into the surfaces immediately prior to the placing of the topping or screeds.

    c. Use Traprock aggregate mix for interior floor toppings.

    d. Use 10 mm normal aggregate mix for screeds, grouts and other toppings.

    e. Spread the material over the areas shown on the Drawings and level off at a thickness to suit the final floor levels.

    f. Screed, float and/or steel trowel as for plain concrete, or emery shake if an interior slab left exposed.

5. Emery Shake:

    a. Float the final surface of the concrete with a disc type power float and compact to a smooth surface, free of voids, and give a monolithic emery shake topping consisting of a dry mixture of Portland cement and emery aggregate in the proportion by weight of 1 cement to 2 aggregates.

    b. Evenly distribute the mixture over the floor at a rate of 30 kg of aggregate per 10 sq. metres of floor, in two applications, and mechanically compact after each application.

    c. When the surface has hardened sufficiently so that excess fines will not be brought to the surface, trowel the floor by using a type of mechanical trowel approved by the Consultant, and finish by hand trowelling to a smooth, hard, dense surface, free from lines, bulges and blemishes.

3.26 FINISHING FORMED SURFACES

A. Four (4) classes of areas require finishing:

1. Class 1 – Architecturally sensitive areas which consist of the inside of buildings, ceilings and exteriors and where indicated on the Drawings.

2. Class 2 – Surfaces which are not backfilled against.

3. Class 3 – Surfaces which are backfilled against and waterproofed.

4. Class 4 – Surfaces which are backfilled against and not waterproofed.

B. Finish surfaces in accordance with the requirements of CSA-A23.1 for treatment of formed surfaces. Read appropriate Sections of CSA-A23.1 before submitting tender and again before commencing work.

C. For Class 1 and 2, machine grind the surface to a smooth texture upon completion of the treatment in B. above.

D. Finish surfaces in Class 1 as an architectural finish with a first-class sack rubbed finish to produce a uniform appearance. Prepare sample sections for approval prior to proceeding with the work.

E. Finish surfaces in Classes 2 and 3 as exposed concrete and provide a sack rubbed finish.

F. Finish surfaces in Class 4 areas above as non-exposed concrete and do not provide a rubbed finish.

G. Any surface repair work identified under Clause 3.26.2, when form liner is used, shall obtain Consultant's acceptance.

3.27 REPAIR OF TEMPERATURE AND SHRINKAGE INDUCED CRACKS

A. Repair cracks in the completed structures employing a suitable polyurethane injection technique to make such cracks completely watertight after repair. For non-liquid or non-earth retaining structures, a suitable epoxy injection to repair the cracks maybe considered.

B. Remove surface injection materials following completion of the work and finish affected areas to match surrounding concrete.

3.28 REPAIR OF BONDED CONCRETE TOPPING

A. If an area of the topping is poorly bonded or delaminated, saw cut through the topping but not into the underlying concrete to neat rectangular lines, as agreed with the Contract Administrator, and remove and replace the topping over the affected area back to the sawn edges.

3.29 PATCHING OF AREAS OF UNSOUND CONCRETE

A. Prime exposed reinforcing bars with epoxy bonding adhesive in accordance with the Manufacturer's printed instructions.

B. Use mix of various consistencies of repair mortar for application to horizontal, vertical, and overhead applications in accordance with the Manufacturer’s printed instructions.

C. Use aggregates in repair mortar consisting of clean, washed, uniformly graded silica sand and pea gravel where required in accordance with the Manufacturer’s printed instructions.

D. Patch deteriorated areas.

E. Fill voids, between the underside of the roof slab and supporting walls and columns.

F. Where required, apply repair mortar in suitable, self-supporting layers permitting adequate heat dissipation. Build layers up gradually to a thickness matching the original concrete surface.

G. Cure patches in accordance with the Manufacturer's printed instructions.

H. Finish patches to match the surrounding adjacent concrete surface.

3.30 TEST PANELS OF CONCRETE FINISHES

A. Provide test panels 1.8 m x 1.2 m in size for Consultant's approval before starting work to the following schedule:

1. Plain Concrete: – Class 1
   – Class 2
   – Class 3

B. Show on panels the specified finish including formwork tie holes and plugs.

C. Erect panels individually or build-in on site in areas selected by the Consultant.

D. Form as many panels as necessary until written approval has been issued by the Consultant.

E. Upon approval, maintain sample panels in place throughout duration of Contract as standard of workmanship to be adhered to.

F. Upon completion of concrete work remove and dispose of the test panels off the site.

3.31 ALTERATIONS TO EXISTING CONCRETE

A. General:

1. Cut out, remove, or modify parts of existing concrete structures, roughen surfaces, cut keys, weld bars, and carry out other items of work as required.

2. Use satisfactory methods which will not result in damage to equipment or other parts of the structures by vibration, dust, water, or other contaminants.

3. Verify existing conditions before beginning alterations.

4. After alterations are done, repair any surface defects and damaged areas and finish surface to match the adjacent areas.

B. Saw Cut Prior to Breaking-Out:

1. Check the perimeter of any area to be broken out with a cover meter to ensure that the reinforcing steel that is to remain is known in position and depth.

2. Sawcut the perimeter to a depth of 25 mm, or less locally where the retained rebar is closer to the surface.

3. Breakout concrete square to the surfaces.

C. Construction Joints to Existing Concrete:

1. Roughen the existing concrete surface to a texture of +6 mm and provide thoroughly bonded concrete.

2. Install a cold joint waterstop and seal to the exposed face. Inject after casting, as required above.

D. Finishing of Existing Concrete Surfaces:

1. As a result of alterations where previous exterior faces become interior, finish the surface to achieve a Class 1 finish as follows:

a. Abrasive blast cleans the entire surface.

b. Patch surface depressions with sand-cement mortar.

c. Grind smooth fins and protrusions.

d. Apply a sack-rubbed finish to the entire exposed surface to match the adjacent interior surfaces.

E. Refinishing:

1. Refinish cut edges of openings flush and smooth, with a bonding agent and concrete or with a non-shrink, non-ferrous, pre-blended hydraulic cement grout of the same colour as the adjacent concrete.

2. Cut back exposed reinforcing bars 50 mm from the finished surface level and apply corrosion inhibitor to cut rebar. Fill/patch voids at each bar with non-shrink grout. Grind edges smooth after repairs and modifications have been completed.

F. Existing Reinforcing Dowels Encased in Lean Concrete or Lime Mortar:

1. Break out existing encasement and expose reinforcing dowels and waterstops. Clean individual bars to bare metal by abrasive blast cleaning. Straighten bars as required.

2. Report any missing or damaged reinforcing bars to the Consultant before proceeding further.

3.32 CLEAN-UP

A. Promptly as the work proceeds and upon completion, clean-up and remove from the site, rubbish and surplus material resulting from the work of this Section.

CONCRETE POUR RELEASE FORM	**Submission No.**
Don Lita Lift Station Upgrades **Greater City of Sudbury** **Contract No.**	

LOCATION OF POUR .....

DATE OF POUR ..... TIME OF POUR .....

* NOTE: Consultant is to be given 24 hours' notice before time of pour

MIX #: **VOLUME ORDERED:**

1. All items of work have been completed for this pour and the following foremen have approve their work ready for inspection:

LINE AND LEVELS: ..... DATE : ..... TIME : .....

STRUCTURAL INSERTS & ANCHORS ..... DATE : ..... TIME : .....

REBAR STEEL: ..... DATE : ..... TIME : .....

MECHANICAL SLEEVES
INSERTS AND PIPING: ..... DATE : ..... TIME: .....

ELECTRICAL SLEEVES AND
INSERTS: ..... DATE : ..... TIME : .....

ARCHITECTURAL INSERTS: ..... DATE : ..... TIME: .....

2. The formwork and falsework has been inspected by the formwork and falsework design engineer or his authorized designate for conformance to the formwork and falsework design.

Formwork and Falsework Design Engineer DATE……. TIME…….

FINISH REQUIRED ----------

EQUIPMENT AND FINISHERS READY ----------

PART 1. CURING REQUIRED ----------

FOGGING REQUIRED ----------

EQUIPMENT READY ----------

5. I have checked all items for this pour and request your inspection before pouring.

6. The items of work have been inspected:

The pour may proceed subject to the Contractor being responsible for the work in accordance with the Contract: (Check) ☐

or

Corrections are required as noted below: (Check) ☐

Resident Supervisor DATE TIME

NECESSARY CORRECTIONS AND REMARKS:

END OF SECTION

PART 1. GENERAL

1.1 SCOPE OF WORK

A. This Section covers the supply and construction of precast Valve chamber and appurtenances called for or implied by the Contract Drawings.

1.2 RELATED SECTIONS

A. All Sections of Division 1

B. Section 02150 – Bracing and Shoring.

C. Section 03300 – Cast-In-Place Concrete.

D. Section 07100 – Waterproofing and Dampproofing.

E. Section 07211 – Board Insulation.

1.3 REFERENCES

A. Comply with the following statutes, Codes and Standards, and all amendments thereto:

1. The Ontario Building Code (OBC) and National Building Code of Canada (NBC).
2. CSA-A23.1, Concrete Materials and Methods of Concrete Construction.
3. CAN/CSA A23.3, “Design of Concrete Structures”.
4. CSA-A23.4, Precast Concrete – Materials and Construction.
5. CSA-A251-M, Qualification Code for Manufacturers of Architectural and Structural Precast Concrete.
6. CSA-G30.5-M, Welded Steel Wire Fabric for Concrete Reinforcement.
7. CSA-G30.18-M, Billet-Steel Bars for Concrete Reinforcement.
8. CSA-G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.
9. CSA-W186-M, Welding of Reinforcing Bars in Reinforced Concrete Construction.

1.4 DESIGN

A. Provide a complete design utilizing engineered precast concrete products where shown on Contract Documents.

B. Have the design prepared and stamped by Professional Engineer licensed to practice in the Province of Ontario and experienced in Precast Concrete Design with minimum of five (5) years experience of similar work. Provide quality assurance services to the engineering designs.

C. Design all precast chamber elements for wet exposure conditions. Provide Type 304 Stainless Steel connection hardware, welding, inserts, and anchor bolts. Ensure surfaces are free draining. Provide 50 mm clear cover to reinforcement or any embedded steel materials.

D. Design in accordance with the loadings shown on the Contract Drawings and in accordance with the Ontario Building Code requirements.

E. In addition to the loads shown on the Contract Drawings and/or required by the governing codes, design of precast structures to include the effects caused by moisture and temperature changes, shrinkage, creep in component materials and handling, within deflection limitations of the supporting structure.

F. Reinforce precast units to safely sustain loads that may be applied to them. Provide sufficient reinforcement to resist cracking and spalling due to thermal conditions and/or handling process during the construction.

G. Design precast elements to support/retain earth and/or water as watertight structures in accordance with ACI 350 Code – Environmental Engineering Concrete Structures.

1.5 BASIS OF PAYMENT

A. Payment for chambers to be included in the Lump Sum Price stated in the Form of Tender for Division 3.

1.6 SUBMITTALS

A. Submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings:

1. Prepare and submit Shop and Layout Drawings, as necessary for construction or as requested by the Consultant.

2. Review Shop Drawings prior to submission. Assume responsibility for confirming and correlating quantities and dimensions, selecting fabrication processes and techniques of construction, and coordinating the work of all trades.

3. Highlight every change made from the Contract Documents.

4. Do not commence work in items covered by Shop Drawings before the Consultant has reviewed the Drawings.

5. The Consultant will review the Drawings only to check conformance with the design concept of the project. Reviewed Drawings will be returned marked 'Reviewed', 'Reviewed as Noted', or 'Revise and Resubmit'.

6. Review of Shop Drawings does not relieve the Contractor from compliance with requirements of the Contract Drawings and Specifications nor relieve him of responsibility for errors made in the Shop Drawings.

1.7 QUALITY ASSURANCE

A. Refer to Section 01400 – Quality Requirements.

B. Provide certificates of experienced manufacturing, erection and quality assurance services.

C. Have precast concrete elements fabricated and erected by a manufacturing plant certified by the Canadian Standards Association in the appropriate category according to CSA-A23.4/A251.

D. Only precast elements fabricated by certified Manufacturers shall be acceptable.

E. Have metal welding companies certified to CSA-W47.1.

F. Have the manufacturing of precast elements inspected and reviewed at each stage by a Professional Engineer licensed in Ontario.

G. Document all inspections and reviews and provide copies for the Consultant’s records.

H. Notify the Consultant 14 Days in advance of manufacturing the precast concrete structures and allow access for inspection and testing by the Consultant and the testing company.

1.8 WARRANTY

A. Provide a written warranty from the Manufacturer confirming that the precast concrete units will not spall or show evidence of visible cracking from inferior materials or workmanship over a period of five (5) years after completion. Units showing such defects shall be replaced and all affected materials made good at no expense to the Owner.

PART 2. PRODUCTS

2.1 MATERIALS

A. Concrete Mix and Class Exposure Type: Refer to Section 03300.

B. Reinforcing Steel Rebar: Refer to Section 03300.

C. Piping and Valves: Refer to Section 11100.

D. Precast Concrete Maintenance Holes and Catch Basins: As per OPSD 1351.

E. Metals: Refer to Sections of Division 5.

F. Insulation Board: Refer to Section 07211.

1. Extruded Polystyrene Foam Insulation to CGSB 41-GP-14a, Type 4.

2. Minimum Compressive Strength: 240 kPa.

3. Minimum Thickness: 100 mm unless shown on the Drawings otherwise.

4. Acceptable Product: Styrofoam-SM as Manufactured by Dow Chemical of Canada Limited or approved equivalent.

5. Insulation Anchors: Use plastic Hilti IDFP Insulation Anchors or reviewed equivalent, except where board is installed against membrane waterproofing.

G. Valve Boxes:

1. Assembly to Standard Detail included on Contract Drawings.

2. Upper Section: Bibby VB-650D or reviewed equivalent.

3. Lower Section: Bibby Figure VB-850 modified to eliminate base or reviewed equivalent.

4. Locking Cover: Bibby VB-825 or reviewed equivalent.

H. Extension Stems:

1. To be made from cold rolled solid steel shaft with corrosion resistant coating.

2. Couplings: to be of cast iron, pinned or threaded.

3. Operating Nuts: Cast iron collared 50 mm square to match combination handwheel and operating nut on valve.

4. Provide guides to extension stems longer than 3 metres.

I. Stem Guide:

1. Adjustable type.

2. Fabricated steel or cast-iron brackets.

3. Bronze bushed bearing.

4. As supplied by one of the following or reviewed equivalent:

i. Bibby Foundry Ltd.

ii. Clow Canada.

iii. Mueller Limited.

J. Ladders:

1. All ladders shall be aluminum to Standard Detail included on Contract Drawings or where referenced to OPSS Standards.

K. Frame and Covers:

1. To Standard Detail shown on the Contract Drawings or where referenced to OPSS Standards.

2.2 CONCRETE PRECAST MANUFACTURERS

A. Acceptable Precast Concrete Manufacturers:

1. Decast Ltd.

2. Wilkinson Heavy Precast.

3. Or approved equivalent.

PART 3. EXECUTION

3.1 MATERIALS

A. Excavate and backfill to Section 02315.

3.2 CONCRETE WORK

A. Concrete, rebar and formwork work shall conform to Section 03300.

3.3 INSTALLATION

A. Construct chambers at locations shown on the Contract Drawings or as directed by the Consultant during the construction in case of any conflict with existing conditions on site.

B. Complete chambers as pipe laying progresses.

C. Cast bottom slab against work/mud slab as shown on the Contract Drawings.

3.4 PIPING AND VALVES

A. Install piping and valves per Contract Documents.

B. Install concrete blocks and valve support brackets under valves as illustrated on the Contract Drawings.

3.5 MISCELLANEOUS METALS

A. Install miscellaneous metals per Contract Documents.

3.6 WATERPROOFING

A. Preparation:

1. Place covers on all pipes/penetrations to prevent extraneous material from entering the sewers or other pipes.

2. Remove all foreign material from the chamber wall and benching using a high-pressure water spray (minimum 2,000 psi). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer, chisel and/or scraper. Fill any large voids with patching material.

3. Stop active leaks using quick setting, specially formulated mixes according to Manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during the application. After application, the contractor shall plug the weep holes with infiltration control material prior to the application of the final coat. When severe infiltration exists, the Contractor may be required to drill into the structure and pressure grout. Manufacturer's recommendations shall be followed when pressure grouting is required.

B. Field Testing:

1. The precast concrete structure shall be visually inspected for leakage/cracks and for a smooth, even finish with good bonding to the coating/waterproofing system as required by Product Manufacturer.

2. Prior to installing a coating/waterproofing system, the precast concrete structure shall exhibit no visible leakage in the structure and around pipe penetrations. Any leakage shall be corrected and sealed to the Consultant's satisfaction.

3. Polymer based lining systems may be used for waterproofing subject to the Consultant's approval.

3.7 INSULATION

A. Install insulation on roof, wall and in access way to 1500 mm below grade unless otherwise shown differently on the Contract Drawings.

B. Install insulation to Manufacturer's recommendations. Use only stainless steel or plastic screw/anchor to attach the insulation boards to concrete surfaces.

3.8 VALVE EXTENSION STEMS AND BOXES

A. Install valve stems and boxes where shown on the Contract Drawings.

B. Install valve box caps flush with final grade.

C. Extension stem guides to be anchored securely to concrete wall or slab, in vertical alignment.

3.9 SUMPS

A. Construct sumps 400 mm square x 200 mm depth in locations where noted on the Contract Drawings.

B. Sumps in precast chambers to be combination of 150 mm depth in the precast base and depth provided in the concrete benching.

C. Provide drains where noted on the Contract Drawings.

D. Slope top of benching to sump.

3.10 LIFTING HOOKS

A. Install lifting hook over all valves of 300 mm diameter and larger and above all air valves and magnetic flowmeters.

B. The General Contractor shall coordinate with the Manufacturer regarding the details of the equipment and instrumentation for the lifting hook design.

C. Design capacity for lifting hooks shall be equal to the 1.5 x weight of valves or flowmeters unless shown on Contract Drawings.

3.11 DAMAGED UNITS

A. Remove damaged units from the site and replace with new units and as directed by the Consultant.

B. Minor damages might be repaired on site subject to submission of repair procedure and acceptance of the Consultant.

3.12 CLEAN-UP

A. As the work proceeds and upon completion, clean-up and remove from the site, any rubbish and surplus material resulting from the work of this Section.

END OF SECTION

PART 1. GENERAL

1.1 INTENT

A. This Section covers repairs and restoration of existing concrete surfaces at the following areas:

1. Existing wet well concrete structure (walls and slabs).
2. Existing generator building (ground floor).
3. Also, other locations where shown on the Contract Drawings.

B. The areas of concrete repair shall be determined by the Consultant and shall include any location where erosion of concrete or acidic attack of the concrete surfaces has reached a depth of 10 mm (or deeper) and at any air voids, bug-holes or poorly consolidated concrete areas where the specified filler/surface materials cannot be used for filling or surfacing of the concrete.

C. The repair work specified herein is intended to cover the requirements for repair of concrete only, to a maximum depth of approximately 100 mm. If after cleaning, an area is discovered that requires a repair greater than 100 mm deep, or an area is discovered that requires repair or replacement of reinforcing steel notify the Consultant so that details may be provided to the Contractor to complete the repair.

D. Section Includes:

1. Preparation/cleaning of existing concrete surfaces.
2. Crack repair by polyurethane material injection.
3. Crack repair by epoxy material injection.
4. Patching spalled and unsound areas with non-shrink cementitious grout or mortar products as applicable.

E. Scope of Work:

1. The following items shall be the base scope of work:

    a. Crack Repair: Preparation and sealing of cracks per Consultant's direction. Supply and installation of approved polyurethane/epoxy material by injection. Contractor shall allow for crack repair per Contract Provisional items.

b. Concrete Spall Repair: Supply and installation of repair mortar/grout/concrete including surface preparation of spalled and unsound concrete. Contractor shall allow for removal and replacement of unsound concrete per Contract Provisional Items.

c. Expansion/Isolation Joint Repair: Cleaning and preparation and sealing of joints. Supply and installation of joint filler, backer rod and joint sealant as applicable to waster water exposure. Contractor shall allow joint repair per Contract Provisional Items.

d. Include for mobilization, scaffolding, heating, curing, ventilation, testing, and tools required to carry out work as specified, and demobilization, in the unit rate of Contract Provisional Items.

F. Measurement:

1. Refer to estimated quantities for each type of repair as listed in the Provisional Items in the Tender Form.

2. Crack Repair: The quantities in linear meters to be measured for payment shall be the actual length of cracks repaired by the methods and materials specified under:

   a. Epoxy crack repair.

   b. Flexible polyurethane crack repair.

   c. Rigid polyurethane crack repair.

3. Concrete Spall Repair: The quantities in square meter to be measured for payment shall be the actual square meter of spalled concrete repaired by the method and materials specified under spall repair.

4. Expansion Joint Repair: The quantities in meters to be measured for payment shall be the actual length of joints repaired by the methods and materials specified under joint repair.

1.2 RELATED SECTIONS

A. Related work in this Section is specified in, but not limited to, the following Sections:

1. Division 1 Sections.

2. Section 03300 – Cast-In-Place Concrete.

1.3 SUBMITTALS

A. Submit in accordance with Section 01330 – Submittals.

B. Include: Manufacturer's surface preparation requirements, SDSs, Coating Specifications, Application Instructions, Application Equipment Specification, Applicator's experience and acceptance as required herein.

C. Prior to the start of the project, provide the Consultant with certified copies of the Manufacturer's quality control testing records.

D. Submit a detailed description of the equipment, grouting, and patching operations, including but not limited to:

1. Procedures proposed for the accomplishment of repair work. Include a detailed description of the methods and equipment to be used for each operation, and the sequence of operations to be coordinated with other works in progress.

2. Manufacturer's recommendations and Product Data Sheets for all repair materials including performance criteria, surface preparation, ambient condition requirements and applications, curing requirements, Volatile Organic Compound (VOC) data and safety requirements.

3. Safety Data Sheets (SDSs) for any materials brought on-site including all repair system materials, solvents, and abrasive blast media.

4. Qualifications of applicators demonstrating compliance with the minimum requirements specified.

5. Quality control during installation including heating, mixing methods and control of variable pressures.

G. Submit certification that the repair materials are suitable for use in continuous submergence in wastewater applications.

1.4 QUALITY ASSURANCE

A. Services of Manufacturer's Representatives:

1. Provide the services of a qualified Manufacturer's Technical Representative to instruct the Contractor's personnel in the mixing, proper use and application of the epoxy, polyurethane, polymer-modified and cement-based compounds.

2. The Manufacturer's Service Representative shall provide on-site inspection services as follows: (a) Before application, to examine suitability of the substrate, and (b) during and after application, to verify that specified products are properly applied and cured.

3. Provide written certification from the Manufacturers' Representative that materials have been mixed and applied properly and surfaces to receive these products have been prepared properly, all in conformance with Manufacturer's requirements.

B. Employ only applicators authorized by material Manufacturer and who specializes in this type of repair work:

1. Ensure that all Work is performed by an experienced, competent applicator licensed and/or approved by the concrete repair material Manufacturer. Submit the Manufacturer's certification of this approval along with a list of similar projects and references where the proposed Subcontractor has installed the same concrete repair works.

2. Ensure that the applicator's installation equipment and methods are approved by the Concrete Repair Material Manufacturer. Submit proof of this approval.

C. Adhere strictly to the Manufacturer’s recommendations regarding temperature at time of application for all work. Do not use epoxy materials when either the temperature of the concrete to be repaired or the minimum ambient temperature recommended by the Manufacturer, 24 hours before, during, or for a period of 48 hours after the completion of the repair. Temporary heat may be used to meet the specified requirements.

1.5 SEQUENCING AND SCHEDULING

A. Schedule work such that the repair work under this Section is completed prior to the commencing of process upgrades or other works of the Contract.

1.6 CONCRETE REPAIR PERFORMANCE REQUIREMENTS

A. The injected epoxy/polyurethane repair resins shall fill the cracks and joints and in no case shall the depth of penetration of the injection material be less than 90 percent of the full thickness of the concrete section for cracks.

B. The cured injected epoxy/polyurethane injection resin shall form a dense rubber-like flexible foam compression gasket-type seal.

C. Any repair mortar used shall be deemed compatible with applied coating or toppings by Manufacturers of both products. Preparation of concrete and application of mortar shall be done in accordance with ACI, ICRI and Manufacturer’s recommendations.

1.7 PRE-REPAIR MEETING

A. Required Meeting Attendees:

1. Consultant and/or City.
2. General Contractor.
3. Repair Subcontractor responsible for concrete repair.
4. Technical Representative for Repair Material's Manufacturer.

B. Schedule and conduct meeting prior to incorporation of respective products into project. Notify Consultant of location and time.

C. Agenda shall include:

1. Review of field conditions. Conduct field observations of work to be performed.
2. Based on above observations, Repair Material Manufacturer's Technical Representative shall make material selection and repair method written recommendations.
3. Technical Representative for Repair Material Manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
4. Other specified requirements requiring co-ordination.

1.8 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Package of material in new sealed containers and label with the following information.

1. Manufacturer's name.
2. Product name and lot number.
3. Mix ration by volume instructions.
4. Generic type of material.
5. Hazardous material identified label.
6. Shelf life date.

1.9 WARRANTY

A. Provide a written warranty from the Manufacturer(s) confirming that the concrete repairs have been completed per Manufacturer's procedures and instructions. Contractor to provided warranty of a period of five (5) years after completion of all repairs. Areas showing defects shall be reworked by removing all affected materials and applying new materials at no expense to the Owner.

PART 2. PRODUCTS

2.1 MATERIALS

A. Concrete Protective/Cementitious Waterproofing Coating:

1. Cem-Kote Flex CR with Cem-Kote Barrier Cote 100, by W.R. Meadows of Canada.
2. Sika Top Seal 107CA by Sika Canada Inc.
3. Mapelastic by Mapei Canada.

B. Polyurethane Injection Grout:

1. Sika® Injection-310 US, by Sika Canada Inc.
2. Resfoam HB 45 by Mapei Canada.
3. Multiurethanes Limited, Mississauga, ON.
4. Or approved equal.

C. Epoxy Crack Repair: Epoxy crack repair binder shall be a two-component, 100 percent solids, high-modulus, low viscosity epoxy adhesive suitable for crack grouting by injection or gravity feed:

1. Sikadur 53 by Sika Canada Inc.
2. Epojet LV Epoxy by Mapei Canada.
3. Or approved equal.

D. Epoxy Bonding Adhesive:

1. Sikadur 32 Hi Mod by Sika Canada Inc.
2. Planibond AE by Mapei Canada.

3. Or approved equal.

E. Repair Mortar:

1. Sikatop 123 Plus Polymer Modified, Cementitious, Non-Sag Mortar, by Sika Canada Inc. (for surfaces not in contact with water).

2. MasterEmaco S 488CI, by Sika Canada Inc.

3. Planitop 12 SR, by Mapei Canada.

4. Or approved equal.

F. Repair Grout

1. SikaGrout 212-SR by Sika Canada Inc.

2. MasterEmaco S 488CI by Sika Canada Inc. (Sprayable, fiber-reinforced structural repair mortar with integral corrosion inhibitor).

3. Planigrout 712 by Mapei Canada.

4. Or approved equal.

G. Anti Corrosion Coating and Bonding Agent: Thermally compatible with substrate concrete and compatible with repair mortar.

1. SikaTop Armatec 110 Epocem by Sika Canada Inc.

2. Or approved equal.

H. Joint Repair:

1. Joint Filler-Foam/Cork:

a. Rodofoam PR with Rodofast Adhesive by Sternson.

b. Cermar by W. R. Meadows.

c. Cork by W.R. Meadows.

2. Rope: With diameter 50 percent larger than joint width:

a. Ethafoam by Dow Chemical.

b. Backer Rod by Acrew Richmond.

3. Sealant at Isolation: Two-component polysulphide sealant applied according to the Manufacturer's instructions or recommendations:

    a. Sikaflex-2CNS/Sikaflex-2cSL/Sikaflex-2c NS EZ Mix by Sika as applicable.

    b. Primer: As recommended by Sealant Manufacturer.

    c. Bond Breaker: An inert film such as polyethylene sheet or masking tape.

PART 3. EXECUTION

3.1 GENERAL

A. Various materials used for the repair work may emit toxic fumes during the application and curing stage. Handle with care and adequately ventilate work area.

B. Provide suitable protective clothing, gloves, breathing apparatus for persons working with restoration materials.

C. During installation and curing of restoration materials, if the ambient temperature is expected to go below the recommended minimum temperature provide enclosures and heat as required.

D. Use restoration materials in accordance with Manufacturer's printed instructions, and as specified.

E. Provide access platforms as required.

F. Continuously check materials and applications for correct use.

3.2 GENERAL CLEANING AND SURFACE PREPARATION

A. Use power wash with minimum 4000 psi pressure to clean and remove existing sludge, residue, stain, mold, etc., and prepare concrete surfaces for inspection of repair works and gas proofing, waterproofing (where required). Do not damage any existing structures.

B. Do not use abrasive blast cleaning on stainless steel.

C. Repair any damage caused by the cleaning process.

D. Remove and dispose cleaning water and waste outside the site.

3.3 PREPARATION OF CRACKS FOR POLYURETHANE GROUT INJECTION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with Polyurethane Manufacturer's instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter to expose the full extent of cracks.

D. Do not use acids and corrosives for cleaning, unless neutralized prior to injecting.

3.4 INJECTION OF CRACKS – POLYURETHANE GROUT

A. Entry Points:

1. Establish openings for polyurethane entry along crack.

2. Determine space between entry ports equal to thickness of concrete member to allow polyurethane to penetrate to the full thickness of the member.

3. Drill injection holes at 45-degree angle to the surface and on alternate sides of a crack, where possible, to intercept cracks. Space holes as close as required. Maximum spacing is 300 millimeters on center.

4. Provide a means to prevent concrete dusts and fines from contaminating the crack or ports when drilling.

5. Install injectors into drilled holes

6. Apply surface sealer along crack surface as required.

7. Flush cracks with clean water.

B. Polyurethane Injection:

1. Inject polyurethane grout into cracks in accordance with Manufacturer's written instructions.

2. Start injection into each crack at lowest injector on a vertical face and at one end on a horizontal surface.

3. Continue injection until pure uncontaminated material flows out from adjacent injectors.

4. Cap injectors and proceed to adjacent injectors until all injectors have been filled.

C. Finishing:

1. Upon completion, remove injectors, surface seal material and injection polyurethane runs and spills from concrete surfaces.

2. Thoroughly clean the concrete surfaces of excess grout material.

3. Prepare concrete for application of gas proofing, waterproofing, or traffic topping, where required. Finish surface to match surrounding concrete.

4. Patch injection holes with non-shrink cementitious grout.

3.5 EQUIPMENT FOR POLYURETHANE GROUT INJECTION

A. Portable, positive displacement type pumps with in-line metering to meter and mix two adhesive components and inject mixture into crack.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.

2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.

3. Capable of immediate compensation for changes in resins.

4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed components at pressures up to 200 psi, plus or minus 5 percent, and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain Polyurethane Manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.

2. Pressure gauge capable of sensing pressure behind each valve.

3.6 EPOXY CRACK REPAIRS

A. Cracks on Horizontal Surfaces: When permitted by the Consultant, repair existing structural cracks by gravity feeding an epoxy crack repair binder into the prepared crack.

1. Rout concrete surface at the crack to form a minimum 6 mm wide by 6 mm deep V-notch and clean to remove all loose and foreign particles. Fill crack with clean, dry sand and pour epoxy crack repair binder into V-notch, completely filling crack.

2. As binder penetrates into crack, apply additional binder to the V-notch.

B. Cracks on Vertical or Horizontal Surfaces: Repair existing structural cracks by pressure injecting an epoxy crack repair binder into the prepared crack. Seal cracked surfaces and install injection ports per Manufacturer's recommendations.

1. Do not cut reinforcement steel when drilling holes injection ports. If rebar is encountered during drilling, abandon the hole, and relocate. Patch the abandoned hole immediately with epoxy mortar flush with the surface of the existing concrete.

2. Once the surface sealing material has cured, inject crack with epoxy crack repair binder as directed by the Manufacturer.

3. Remove injection ports upon satisfactory completion of crack injection and patch with epoxy mortar.

3.7 PATCHING/REPAIRS OF AREAS OF UNSOUND CONCRETE

A. Complete visual examination and delamination survey on site in the presence of the Consultant to evaluate the existing conditions. The exact location and extent of concrete repairs will be determined and designated by the Consultant.

B. Where concrete repair area is more than 10 mm thick, saw cut edges around the repair area to form square edges from the surface to the depth of the removed concrete or 10mm shorter than any rebar whichever is shorter. Do not damage any existing rebar.

C. Where concrete surface imperfections are extended till reinforcement rebar, clean exposed rebar with sand blasting to remove any rust or lose concrete. Apply zinc-rich coating to exposed rebar prior to any mortar applications.

D. Fill repair areas with approved repair grout and trowel to smooth finish.

E. Maintain the environmental conditions specified by the Product Manufacturer during the application and curing of the repair grout.

F. Application of concrete repair mortar shall conform to the Manufacturer's recommendation.

G. Protect repair areas from snow or rain during execution of the work. Repair work shall not be undertaken during rain, snow, or freezing conditions.

H. Dispose any waste materials as a result of cleaning or coating removal outside construction site.

I. Cure patches in accordance with Manufacturer's printed instructions.

J. Finish patches to match surrounding adjacent concrete surface.

3.8 JOINT REPAIR

A. Remove sealant, bond breaker and joint filler.

B. Remove unsound concrete on the joint faces and repair with non-shrink grout.

C. Remove laitance and provide a clean dry surface.

D. Prepare an epoxy mortar by combining epoxy crack repair binder with aggregate following the Manufacturer's instructions.

E. Restore surface to original dimensions by troweling epoxy mortar onto the existing substrate in a manner to ensure bonding following the Manufacturer's instructions.

F. Cure repair in accordance with the Manufacturer's instructions.

G. Install new joint filler, bond breaker and sealant where required for expansion joints.

3.9 FIELD QUALITY CONTROL

A. Take samples of injection material at regular interval of material on plywood boards. Record time and date for each sample.

B. Engage Polyurethane Materials Manufacturer's Representative for inspection service:

1. Before application, to examine suitability of the substrate.

2. During and after application, to ensure that specified products are properly applied and cured.

C. Carry out sample testing of the polyurethane at the beginning and at regular intervals to verify correct mixing proportion, consistency and setting time.

D. Crack injection will only be accepted if the polyurethane grout achieves a minimum of 90 percent penetration of the crack depth. Notwithstanding the foregoing, injected cracks or joints found to exhibit leakage shall be deemed as deficient work irrespective of the depth of penetration. Carry out reinjection of deficient work as required to meet the performance requirements at no cost to the City.

E. Prepare and perform compressive strength specimens from repair grout material for testing at 7, 14, and 28 days (or where stated differently on repair material data sheet by Product Manufacturer). Submit test results for the Consultant to review and record.

F. Prepare and perform tensile bond strength testing for patch repair and/or resurfacing on concrete surfaces per Repair Product Manufacturer's recommendations. Submit test results for the Consultant to review and record.

G. Choose representative areas for testing that reflect typical conditions of the patch repair. Samples for the tensile bond test shall be selected with adequate size and shape as required by the testing standard and/or Product Manufacturer's recommendations.

3.10 CLEAN-UP

A. As the Work proceeds and upon completion, clean-up and remove from the site, any rubbish and surplus material resulting from the work of this Section.

END OF SECTION

DIVISION 5

METALS

INDEX

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 05516 – Aluminium Ladders.

B. Section 05550 – Anchorage in Concrete and Masonry.

C. Section 05999 – Miscellaneous Metals.

D. Section 03300 – Cast-In-Place Concrete.

1.2 REFERENCES

A. ASTM A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

B. CAN/CGSB-1.40 – Primer, Structural Steel, Oil Alkyd Type.

C. CAN/CGSB-1.108 – Bituminous Solvent Type Paint.

D. CAN/CGSB-1.181 – Ready-Mixed, Organic Zinc-Rich Coating.

E. CAN/CSA-G40.21 – Structural Quality Steels.

F. CAN/CSA-S157 and S157.1 – Aluminum Design and Fabrication.

G. CAN/CSA-G164 – Hot-Dipped Galvanizing of Irregularly Shaped Articles.

H. CAN/CSA-S16 – Limit States Design of Steel Structures.

I. CSA-W59 – Welded Steel Construction (Metal Arc Welding).

J. ASTM 276 – Type 316 Stainless Steel.

1.3 DESIGN REQUIREMENTS

A. Design miscellaneous metal items and connections in accordance with the applicable standards.

B. Have the design work under this Section, for elements which will support other items, or which will be required to support structural loads of any nature, prepared by a Professional Structural Engineer licensed in the Province of Ontario.

C. Design connections and splices using high strength bolts or welds. Use bearing type bolts for bolted connections.

D. Design connections for the moments, shears and axial loads indicated or specified in the Contract Documents.

E. Where no moments, shears or axial loads are indicated, design in accordance with CSA-S16 requirements for Simple Construction. Design connection for the end reactions of a laterally supported beam of a given span under a uniformly distributed load that has attained its maximum moment capacity.

F. Design connection for Hollow Structural Sections to develop the full strength of member in tension or compression.

G. Unless design loads are indicated, design splices for the full strength of the member in bending, shear and axial load.

H. Unless design loads are indicated, design end connections and/or splices in bracing members for the full axial strength of the member.

I. Where overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Where there is any evidence of rusting or deterioration of finish in such areas, carry out remedial seal welding and refinishing.

J. Design aluminum work to the requirements of CSA-S157 and CSA-W59.2.

1.4 SHOP DRAWINGS

A. Submit Shop Drawings in accordance with Section 01330 – Submittals.

B. Indicate design loads, design standards, materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories.

C. Provide Shop Drawings sealed by a Professional Engineer registered in the Province of Ontario.

1.5 PROTECTION

A. Cover exposed stainless-steel surfaces with pressure sensitive heavy protection paper or apply strippable plastic coating, before shipping to job site.

B. Leave protective covering in place until final cleaning.

PART 2. PRODUCTS

2.1 MATERIALS

A. Steel Sections and Plates: To CAN/CSA-G40.21, Grade 300W.

B. Welding Materials: To CSA-W59.

C. Welding Electrodes: To CSA-W48 Series.

D. Bolts and Anchor Bolts: To ASTM A307.

E. Aluminum shall conform to the following alloy designations of the Aluminum Association:

1. Extruded Shapes – Structural: 6061-T6.

2. Smooth Plates: 5083-H34.

3. Rivets and Bolts: 6061-T6.

4. Checkered or Tread Plate: 6061-T6.

F. All Stainless Steel: To ASTM A276, Type 316.

G. Grout: Non-shrink, non-metallic, flowable, 24 hour, 15 MPa at 24 hours, pull-out strength 7.9 MPa.

2.2 FABRICATION

A. Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.

B. Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated.

C. Where possible, fit and shop assemble work, ready for erection.

D. Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

2.3 FINISHES

A. Galvanizing: Hot-dipped galvanizing with zinc coating 610 g/m^3 to CAN/CSA-G164.

B. Shop Coat Primer: To CAN/CGSB-1.40.

C. Zinc Primer: Zinc Rich, Ready Mix to CAN/CGSB-1.181.

D. Bituminous Paint: To CAN/CGSB-1.108.

2.4 ISOLATION COATING

A. Isolate aluminum from following components, by means of bituminous paint:

1. Dissimilar metals except stainless steel, zinc or white bronze of small area.

2. Concrete, mortar and masonry.

3. Wood.

2.5 SHOP PAINTING

A. Apply one (1) coat of primer to metal items, with exception of galvanized or concrete encased items.

B. Use primer unadulterated, as prepared by Manufacturer. Paint on dry surfaces, free from rust, scale and grease. Do not paint when temperature is lower than 7ºC.

C. Clean surfaces to be field welded: do not paint.

2.6 SLAB CORNER GUARDS

A. Galvanized steel angle as indicated on the Contract Drawings.

2.7 MISCELLANEOUS LINTEL ANGLES

A. Miscellaneous lintel angles as indicated on the Contract Drawings.

2.8 MISCELLANEOUS ITEMS

A. Review all Drawings and include all other metal fabrication not included in the above noted list.

PART 3. EXECUTION

3.1 ERECTION

A. Do welding work in accordance with CSA-W59, unless specified otherwise.

B. Erect metal work square, plumb, straight and true, accurately fitted with tight joints and intersections.

C. Provide suitable means of anchorage acceptable to Consultant such as dowels, anchor clips, bar anchors, expansion bolts and shields, chemically anchored bolts and toggles.

D. Exposed fastening devices to match finish and be compatible with material through which they pass.

E. Provide components for building by other Sections in accordance with Shop Drawings and Schedule.

F. Make field connections with bolts to CAN/CSA-S16 or weld.

G. Hand items over for casting into concrete or building into masonry to appropriate trades together with setting templates.

H. Touch-up rivets, field welds, bolts and burnt or scratched surfaces after completion of erection with primer.

I. Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Conform to Sections of Division 1 as applicable.

B. Section 05500 – Metal Fabrications.

C. Section 05550 – Anchorage in Concrete and Masonry.

D. Section 05999 – Miscellaneous Metals.

E. Section 03300 – Cast-In-Place Concrete.

1.2 DESIGN REQUIREMENTS

A. Comply with CSA S157/A157.1 for strength design in aluminium work.

B. Design ladders to support concentrated vertical load of 1.1 kN applied at the mid span of the rung at maximum deflection of L/360 of clear span.

C. Fixed Roof Access Ladders: Design ladder attachment and anchoring system in compliance with OBC 2012 (Supplementary Standard SB-8).

1.3 QUALITY ASSURANCE

A. Retain a Professional Engineer, licensed in the province of the work, with five (5) years' experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:

1. Structural design.
2. Review, stamp, and sign Shop Drawings.
3. Conduct shop and on-site inspections.
4. Prepare and submit inspection reports.

B. Perform aluminium welding to CSA W59.2 by fabricators certified by the Canadian Welding Bureau to CSA W47.2.

1.4 SUBMITTALS

A. Submittals to be accordance with Section 01330 – Submittals.

B. Shop Drawings: Bearing seal and signature of the Professional Engineer responsible for the engineering design. Show work of this Section including design loads, design standards, large scale detail of members and materials, of connection and jointing details, and of anchorage devices, dimensions, thicknesses, description of materials, metal finishing, as well as other pertinent data and information.

PART 2. PRODUCTS

2.1 MATERIALS

A. Aluminium Shapes and Extrusions: AA6061-T6 alloy, anodizing quality.

B. Welding Rods, Aluminium: 5356 alloy.

C. Fasteners: Stainless steel fasteners.

D. Grout: Non shrink, non-metallic, flowable, minimum compressive strength of 40 MPa at 28 days.

E. Drilled Anchors: As per Section 05550 – Anchorage in Concrete and Masonry.

F. Isolation Coating: Acid and alkali resistant.

2.2 FABRICATION

A. Verify dimensions of existing work before commencing fabrications and report any discrepancies to Consultant.

B. Fit and assemble work in shop where possible. Execute work in accordance with details and reviewed Shop Drawings. Where shop fabrication is not possible, make trial assembly in shop.

C. Unless indicated otherwise, provide welded connection for work of this Section.

D. Screw Assembly: Use self-tapping shake-proof screws on items requiring assembly by screws.

E. Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to Consultant's acceptance.

F. Assemble members without twists or open joints.

G. Correctly size holes for connecting work of other Sections where such can be determined prior to fabrication. Where possible, show holes on Shop Drawings. Place holes not to cause appreciable reduction in strength of member.

2.3 WELDING

A. Perform welding by electric arc process.

B. Execute welding to avoid damage or distortion to work. Execute welding in accordance with following standards:

1. CSA W48: For welding materials. If rods are used, only coated rods are allowed.
2. CSA W59 Series: For design of connections and workmanship.
3. CAN/CSA W117.2: For safety.

C. Thoroughly clean welded joints and expose metals for a sufficient distance to perform welding operations.

D. Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

E. Continuous weld all joints for the full length of each joint. Finish exposed welds smooth and flush, file or grind as required.

2.4 ANCHORS AND FASTENING

A. Use weld studs of size not larger than 10 mm for attaching miscellaneous materials and equipment to building steel structure. If weight of item requires larger fasteners use clips or brackets and secure by welding or through bolting.

B. Use self-drilling expansion type concrete anchors for attaching to masonry and concrete.

C. Before openings are cut through structure, obtain Consultant's written acceptance for procedures, locations and reinforcements required.

2.5 ALUMINIUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminium Association for Designating Aluminium Finishes.

B. Colour Anodic Finish: AA-M12C22A42/A44, as fabricated nonspecular mechanical finish, medium matte etched chemical finish, Architectural Class I, integrally colored or electrolytically deposited color coating of minimum 0.018 mm thick complying with AAMA 611.

PART 3. EXECUTION

3.1 EXAMINATION

A. Verify dimensions and conditions of previously installed work, upon which this Section depends, and coordinate repairs, alterations and rectification if necessary.

B. Obtain Consultant's written approval prior to field cutting or altering of Structural Members.

3.2 ERECTION

A. Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.

B. Perform drilling of concrete and steel as required to fasten work of this Section.

C. Unless otherwise indicated, grout set work in concrete with non-shrink grout. Trowel surface smooth and flush with adjacent surfaces.

D. Insulate metals where necessary to prevent corrosion due to contact between dissimilar metals and between metals and masonry, concrete or plaster. Use bituminous paint, butyl tape, building paper or other approved means.

3.3 FIELD PAINTING

A. Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

3.4 SCHEDULE OF WORKS

A. Ladder Rungs: Bent solid rungs spaced at regular intervals. Forward rungs to other Sections for building in.

B. Access Ladders:

1. Construct access ladders of solid stringers and rungs with rungs rigidly secured to stringers. Provide angle clips and anchor bolts to secure the ladders in place.

    a. Side Rails: Extend minimum 900 mm above landings.

    b. Rungs: Minimum 150 mm from walls and spaced at regular intervals.

C. Grating: Fabricate removable and fixed gratings in sections weighing maximum 25 kg each. Secure removable grating in place with minimum of four (4) clips per panel. Weld fixed gratings at approximately 400 mm o.c. with 25 mm fillets.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Conform to Sections of Division 1 as applicable

B. Section 05500 – Metal Fabrications.

C. Section 05516 – Aluminium Ladders.

D. Section 05999 – Miscellaneous Metals.

E. Section 03300 – Cast-In-Place Concrete.

1.2 SCOPE

A. This Section covers the procurement and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts, adhesive anchors, expansion anchors and epoxy grouted anchor bolts and reinforcing steel to be installed in concrete and masonry.

1.3 GENERAL

A. Unless otherwise specified or indicated on the Drawings, all anchors and anchor bolts shall be cast-in-place anchor bolts with forged heads or embedded nuts and washers. Unless otherwise indicated, bolts in concrete shall have a diameter of at least 20 mm and bolts in grouted masonry shall have a diameter of at least 13 mm.

B. Unless otherwise indicated on the Drawings, anchors and anchor bolts used in the following locations and applications shall be of the indicated materials. Other anchors and anchor bolts shall be as indicated on the Drawings. Where stainless steel is indicated, use Type 316 Stainless Steel.

1. Cast-In-Place Anchor Bolts:

    a. Submerged Locations: Stainless steel.

    b. Locations Subject to Splashing: Stainless steel.

    c. Buried Locations: Stainless steel.

    d. Anchorage of Structural Steel Columns: Galvanized steel.

e. Other Exterior Locations: Galvanized steel.

f. Other Interior Locations: Carbon steel.

2. Threaded Rod and Expansion Anchors:

a. Submerged Locations: Stainless steel.

b. Locations Subject to Splashing: Stainless steel.

c. Buried Locations: Stainless steel.

d. Anchorage of Structural Steel Columns: Stainless steel.

e. Other Exterior Locations: Stainless steel.

f. Other Interior Locations: Carbon steel.

C. Adhesive anchors and expansion anchors may be used instead of cast-in-place anchors where specifically indicated or permitted on the Drawings or with the specific acceptance by the Consultant.

1.4 SUBMITTALS

A. Product Data Sheet for selected materials.

B. Letters of certification indicating the manufacturer and types of adhesive anchors, expansion anchors and epoxy grouts to be supplied shall be submitted in accordance with Section 01330 – Submittals.

1.5 DELIVERY, STORAGE AND HANDLING

A. Materials shall be handled, transported and delivered in a manner that will prevent damage or corrosion. Damaged materials shall be promptly replaced. Materials shall be shipped and stored in original Manufacturer's packaging.

PART 2. PRODUCTS

2.1 MATERIALS

A. Materials shall be as indicated below:

1. Expansion Anchors: Hilti “Kwik-Bolt”; ITW Ramset/Red Head “Trubolt Wedge Anchor”; Powers Fasteners “Power-Stud Anchor”.

2. Reinforcing Bars: CAN/CSA-G30.18 Grade 400.

3. Anchor Bolts and Nuts:

   a. Carbon Steel: ASTM A307 or Grade 300 Rod, with Compatible Nuts.

   b. Stainless Steel: Bolts, ASTM F593 (R2008), Alloy Group 2 (316 SS); Nuts, ASTM F593-02e2, Alloy Group 2.

   c. Galvanized Steel: Carbon Steel Bolts and Nuts; Hot-Dipped Galvanized, ASTM A153/A153M and ASTM A385/A385M.

   d. Flat Washers: ANSI/ASME B18.22M-1981 (R2005); of same material as Anchor Bolts and Nuts.

4. Threaded Rod Anchors and Nuts:

   a. Carbon Steel: Grade 300W Rod, with Compatible Nuts.

   b. Stainless Steel: Rods, ASTM F593 (R2008), Alloy Group 2 (316 SS); nuts, ASTM F594, Alloy Group 2.

   c. Galvanized Steel: Carbon Steel Rods and Nuts; Hot-Dipped Galvanized, ASTM A153/A153M and ASTM A385/A385M.

5. Adhesive Anchors for Concrete and Grout Filled Masonry:

   a. Threaded Rods and Nuts: As specified for Threaded Rod Anchors and Nuts and as recommended by the adhesive manufacturer.

   b. Adhesive: Hilti “HIT HY 200”, “HIT-ICE”, “HIT RE500”, or “HVA” Systems.

6. Epoxy Grout for Reinforcing Bars, Threaded Rod Anchors and Anchor Bolts:

   a. Adhesive for Floors and Horizontal Surfaces: Sika “Sikadur 35, Hi-Mod LV”; ChemRex “Concresive Liquid LPL”; Sika “Sikadur 32 Hi-Mod”, Hilti “HIT RE500”.

b. Adhesive for Vertical Surfaces and Overhead Applications: Sika “Sikadur 31 Hi-Mod Gel”.

c. Aggregate: As recommended by the Epoxy Grout Manufacturer.

d. Water: Clean and free from deleterious substances.

7. Adhesive Anchors for Hollow Masonry System:

a. Threaded Rod Anchors and Nuts: As specified for Threaded Rod Anchors and Nuts and as recommended by the Adhesive Manufacturer.

b. Adhesive: Hilti “HIT HY 20” or “HIT HY 270“ System; ITW Ramset/Redhead “Epcon Ceramic 6” System.

c. Screen Tubes: As recommended by the Manufacturer.

2.2 ANCHORS

A. Cast-in-Place Anchor Bolts: Cast-in-place anchor bolts shall be delivered in time to permit setting before the structural concrete is placed. Anchors bolts shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two (2) nuts, a jam nut and a washer shall be furnished for cast-in-place anchor bolts indicated on the Drawings to have locknuts; two (2) nuts and a washer shall be furnished for cast-in-place anchor bolts without locknuts. Installation of anchor bolts is covered in the Cast-In-Place Concrete Section.

B. Adhesive and Expansion Anchors: When adhesive or expansion anchors are indicated on the Drawings, only acceptable systems shall be used. Acceptable systems shall include only those systems and products specified or specifically indicated by product name on the Drawings. Alternative anchoring systems may be used only when specifically accepted by Consultant. An acceptable adhesive anchor system may be used as an alternative in locations where epoxy grouted anchor bolts and epoxy grouted threaded rod anchors are specified or indicated.

1. Threaded rod anchors in adhesive anchor systems shall be furnished with a sufficient length to provide an embedment depth of at least 20 x rod diameters and free of coatings that would weaken the bond with the adhesive. Unless otherwise required, single nut and washer shall be furnished for threaded rod anchors, adhesive anchors and expansion anchors. Anchor bolts and threaded rod anchors that are to be epoxy grouted shall be clean and free of coatings that would weaken the bond with the epoxy.

2. Adhesive anchors in hollow masonry shall utilize screen tubes as recommended by the Manufacturer.

C. Epoxy Grouted Anchor Bolts and Reinforcing: Epoxy grout for installing reinforcing steel dowels and anchor bolts not indicated to be adhesive anchors shall consist of a two-component liquid epoxy adhesive of viscosity appropriate to the location and application and an inert aggregate filler component, if recommended by the adhesive manufacturer. Components shall be packaged separately at the factory and mixed immediately before use.

1. Anchor bolts and reinforcing steel shall be as indicated on the Contract Drawings.

PART 3. EXECUTION

3.1 GENERAL

A. Anchor bolts shall be installed at the locations indicated on the Contract Drawings.

B. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before final installation and tightening of the nuts.

C. Anchors shall be located at least 100 mm away from conduits, sleeves and drains bodies at their largest point measured on top of the slab above the anchor, and the like, embedded in the concrete.

D. Anchors shall be installed in drilled holes with a minimum depth and diameter specified by the manufacturer unless noted otherwise.

E. Anchors shall be assumed, for determining required anchor size, to be installed in an unreinforced concrete mass.

F. If, when drilling the holes for the anchors, reinforcement is encountered and the hole must be shifted to clear the reinforcement, the abandoned hole shall be patched with non-shrink grout of similar properties as the base concrete.

3.2 CAST-IN-PLACE ANCHORS AND ANCHOR BOLTS

A. Cast-in-place anchors and anchor bolts shall be carefully positioned with templates and secured in the forms prior to placing concrete. Contractor shall verify that anchorage devices are positioned in accordance with the Design Drawings and with applicable Equipment Submittal Drawings. Anchors and bolts shall be positioned sufficiently in advance of the concrete placement so that an on-site representative of Consultant or Owner will have sufficient time to inspect the bolts prior to placing concrete. If special inspection of the anchor bolts is required by the local building code, anchorage shall be placed in sufficient time and with sufficient notification so that such inspection can take place without delaying progress of the work.

B. Threads, bolts and nuts spattered with concrete during placement shall be cleaned prior to final installation of the bolts and nuts.

3.3 EPOXY GROUT

A. Epoxy grout components shall be packaged separately at the factory and shall be mixed immediately before use. Proportioning and mixing of the components shall be done in accordance with the Manufacturer's recommendations.

B. An acceptable adhesive anchoring system may be used where epoxy grouted threaded rod anchors are indicated on the Drawings.

C. Preparation: Where indicated on the Drawings, anchor bolts, threaded rod anchors and reinforcing bars shall be epoxy grouted in holes drilled into hardened concrete. Diameters of holes shall be as follows:

Item	Diameter of Hole
Reinforcing Bars and Threaded Rod Anchors	3 mm larger than the outside diameter of the bar or the rod.
Headed Anchor Bolts	Bolt diameter plus 50 mm and sufficient to clear the bolt head.

D. The embedment depth for epoxy grouted anchor bolts, threaded rod anchors and reinforcing bars shall be at least 15 bolt, rod or bar diameters, unless otherwise indicated on the Drawings.

E. Holes shall be prepared for grouting as recommended by the Epoxy Grout Manufacturer.

F. Installation: Anchor bolts, threaded rod anchors and reinforcing bars shall be clean, dry and free of grease and other foreign matter when installed. The bolts, rods and bars shall be set and positioned, and the epoxy grout shall be placed and finished in accordance with the recommendations of the Grout Manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with epoxy grout, without voids.

3.4 ADHESIVE ANCHORS

A. When adhesive anchors are indicated on the Drawings, only an acceptable system shall be used. Alternative anchoring systems may be used only when acceptable to Consultant. An acceptable adhesive anchor system may be used as an alternative in locations where epoxy grouted anchor bolts and threaded rod anchors are specified or indicated. The embedment depth for adhesive anchors shall be at least 20 x rod diameters unless a greater depth is indicated on the Drawings or as required by the Product Manufacturer.

B. Adhesive for adhesive anchors shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the Manufacturer's recommendations.

C. Anchors shall be installed in holes drilled into hardened concrete or grout filled masonry. Diameter of holes shall be 3 mm larger than the outside diameter of the rod unless recommended otherwise by the Anchor System Manufacturer. Holes shall be prepared for insertion of the anchors by removing all dust and debris using procedures recommended by the Adhesive Manufacturer.

D. Adhesive anchors and holes shall be clean, dry and free of grease and other foreign matter at the time of installation. The adhesive shall be placed, the rods shall be set and positioned, and the adhesive shall be finished, all in accordance with the recommendations of the Material Manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids and remain filled with adhesive until completion of the curing period. Adhesive shall be cured in accordance with the recommendations of the Adhesive Manufacturer.

3.5 EXPANSION ANCHORS

A. When expansion anchors are indicated on the Drawings, only an acceptable expansion anchor shall be used. Alternative systems may be used only when acceptable to Consultant. Expansion anchors shall be installed in accordance with the Drawings, but in no case shall the depth of the hole be less than six (6) bolt diameters. The minimum distance between the centre of any expansion anchor and an edge or exterior corner of concrete shall be at least six (6) times the diameter of the bolt. Unless otherwise indicated on the Drawings, the minimum distance between the centres of expansion anchors shall be at least 12 times the diameter of the bolt.

3.6 QUALITY CONTROL

A. Implement a system of quality control to ensure that the minimum standards specified herein are attained.

B. Bring to the attention of the Consultant any defects in the work or departures from the Contract Documents that may occur during construction. The Consultant will decide upon corrective action and give their recommendations in writing.

C. The Consultant's general review during construction and inspection and testing by independent inspection and testing agencies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

3.7 NOTIFICATION

A. Prior to commencing significant segments of the work, give the Consultant and independent inspection and testing agencies appropriate notification, so as to afford them reasonable opportunity to review the work. Failure to meet this requirement may be cause for the Consultant to classify the work as defective.

3.8 INSPECTION AND TESTING

A. Appointment of Independent Inspection and Testing Companies:

1. The Owner will appoint the independent inspection and testing companies to make inspections or perform tests as the Consultant directs. The independent inspection and testing companies shall be responsible only to the Consultant and shall make only such inspections or tests as the Consultant may direct.

2. When defects are revealed, the Owner may request, at the Contractor's expense, additional inspection or testing to ascertain the full extent of the defect.

B. Tests on Installed Anchors/Epoxy Rebar Dowels:

1. Anchors: The independent inspection and testing company may test up to 10 percent of some of the installed anchors/dowels to the Manufacturer’s specified working load. Should defective anchors or under-capacity installations be found another 10 percentage of installed anchors/dowels will be tested at the Contractor’s expense.

3.9 DEFECTIVE MATERIALS AND WORK

A. Where evidence exists, that defective work has occurred or that work has been carried out incorporating defective materials, the Consultant may have tests, inspections or surveys performed, analytical calculations of structural strength made and the like in order to help determine whether the work must be repaired or replaced. Tests, inspections or surveys or calculations carried out under these circumstances will be made at the Contractor’s expense, regardless of their results, which may be such that, in the Consultant’s opinion, the work may be acceptable.

B. All testing shall be conducted in accordance with the requirements of the Ontario Building Code, except where this would in the Consultant’s opinion cause undue delay or give results not representative of the rejected material in place. In this case, the tests shall be conducted in accordance with the standards given by the Consultant.

C. Materials or work which fails to meet specified requirements may be rejected by the Consultant whenever found at any time prior to final acceptance of the work regardless of previous inspection. If rejected, defective materials or work shall be promptly removed and replaced or repaired to the satisfaction of the Consultant, at no expense to the Owner.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Conform to Sections of Division 1 as applicable.

B. Section 05500 – Metal Fabrications.

C. Section 05550 – Anchorage in Concrete and Masonry.

D. Section 05516 – Aluminium Ladders.

E. Section 03300 – Cast-In-Place Concrete.

1.2 REFERENCES AND STANDARDS

A. ASTM A53/A53M – Specification for Pipe, Steel, Black and Hot-Dip, Zinc-Coated, Welded and Seamless.

B. ASTM A123/A123M – Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

C. ASTM A153/A153M – Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ASTM A325M – Specification for High-Strength Bolts for Structural Steel Joints [Metric].

E. ASTM A653/A653M – Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated by the Hot-Dip Process.

F. CAN/CGSB-1.40 – Anticorrosive Structural Steel Alkyd Primer.

G. CAN/CGSB-1.81 – Air Drying and Baking Alkyd Primer for Vehicles and Equipment.

H. CAN/CGSB-1.181 – Ready Mixed Organic Zinc Rich Coating.

I. CAN/CSA-G40.20/G40.21– General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.

J. CAN/CSA-G164 – Hot Dip Galvanizing of Irregularly Shaped Articles.

K. CAN/CSA-S16 – Design of Steel Structures.

L. CSA-W47.1 – Certification of Companies for Fusion Welding of Steel Structures.

M. CSA-W48 – Filler Materials and Allied Materials for Metal Arc Welding.

N. CSA-W59 – Welded Steel Construction (Metal Arc Welding).

O. CAN/CSA-W117.2 – Safety in Welding, Cutting and Allied Processes.

P. SSPC Steel Structures Painting Council, "Steel Structures Painting Manual Volume 2".

1.3 DESIGN REQUIREMENTS

A. Comply with OBC Code

1. Generally, the Contract Drawings provide information on specific shape and dimensions required and in certain cases. For metal items where only load information is indicated on the Contract Documents, provide steel supports and anchorage for general design indicated, sized to suit specified loads. Provide bracing as may be required to counter lateral loads and dynamic stresses where vibration of support equipment may occur.

1.4 SUBMITTALS

A. Shop Drawings:

1. Submit Shop Drawings in accordance with Section 01330 – Submittals.

2. Show and describe in detail work of this Section including large scale detail of members and materials, of connection and jointing details, and of anchorage devices, dimensions, gauges, thicknesses, description of materials, metal finishing, as well as other pertinent data and information.

3. Shop Drawings indicating structural components shall bear professional stamp and signature of Professional Engineer licensed to design structures and registered in Province of Ontario.

B. Certification:

1. Submit certification from registered Professional Structural Engineer registered in Province of Ontario, who shall affix their seal and signature to certificate, stating structure is capable of supporting its own weight and specified live loads.

1.5 QUALITY ASSURANCE

A. Welder Qualifications:

1. Execute welding by firm certified in accordance with CSA Standard W47.1.

2. Operators employed on work shall be qualified per CSA-W47.1 for work as specified herein.

PART 2. PRODUCTS

2.1 MATERIALS

A. Steel, Structural Quality, WWF, W-Shapes, HSS Sections and Structural Tees: CAN/CSA-G40.20/G40.21, Grade 350W. Products must comply with recycled and regional content requirements as outlined in Section 01061, Item 2.

B. Steel, Structural Quality, Plates, Angles and C-Channels: CAN/CSA-G40.20/G40.21, Grade 300W.

C. Sheet Steel: ASTM A653/A653M.

D. Sheet Steel: Commercial Quality ASTM A1008, stretcher levelled, or temper rolled.

E. Galvanized Sheet Steel: Galvanizing as specified ASTM A653/A653M, structural and commercial quality sheets. Must be specially treated by phosphate conversion process if steel is to be exposed and finish painted.

F. Steel Pipe: ASTM A53/A53M, Extra Strong, Galvanized Finish.

G. Stainless Steel Tubing: To ASTM A269, Type 304, Commercial Grade, Seamless Welded, Exposed Surfaces ANSI No 4 Polished Finish.

H. Welding Materials: Conform to CSA-W48.1-M and CSA-W59-M.

I. Fasteners (Concrete Anchors, Toggle Bolts, and Hammer Driver Bolts) to ASTM A307, Hilti (Canada) Ltd. or Ucan Fastening Products.

J. Metal Filler: Polyester based, White 'Lightning' by Marson Canada Inc. or Combo or First choice by Dura Chemicals Ltd.

K. Conform to following requirements:

1. CAN/CGSB-1.40-M.

2. SPEC. NOTE: Spray Application for Heavy Exposure.

3. CAN/CGSB-1.81.

4. CAN/CGSB-1.181.

2.2 FABRICATION

A. Fit and assemble work in shop where possible. Execute work according to details and reviewed Shop Drawings. Where full shop assembly is not possible, make trial assembly in shop.

B. Do welding to CSA-W59-M. File or grind welds smooth and flush where exposed to view and where specifically indicated on Drawings.

C. Fit joints and intersecting members accurately. Make work in true planes with adequate fastening.

D. Supply fastenings, anchors, accessories required for fabrication of work of this Section. Such items occurring on or in exterior wall or slab shall be hot dip galvanized.

E. Fastenings include without being limited to anchor bolts, machine bolts, toggle bolts, self drilling anchor, lag screws, expansion shields, sleeves, brackets, washers and nuts.

F. Provide bolts with all washers and nuts required for complete installation. Provide lock washers where vibrations may occur.

G. Make exposed metal fastenings and accessories of same material, texture, colour and finish as base metal on which they occur unless otherwise indicated or specified.

H. Keep exposed fastenings to an absolute minimum evenly spaced and neatly laid out.

I. Make fastenings of permanent type unless otherwise indicated.

2.3 SHOP WELDING

A. Execute welding to avoid damage or distortion to work. Should there be, in opinion of Consultant or Inspection and Testing Company, doubt as to adequacy of welds, they shall be tested for efficiency and any work not meeting Standards shall be removed and replaced with new work satisfactory to Consultant. Carry out welding in accordance with following Standards:

1. CSA-W48-M: For electrodes (If rods are used, only coated rods are allowed).

2. CSA-W59-M: For design of connections and workmanship.

3. CAN/CSA-W117.2-M: For safety.

B. Clean welded joints and steel exposed for sufficient space to properly perform welding operation. Neatly finish welds. Welds which will be exposed to view, and finish painted shall be continuous and ground smooth.

2.4 SHOP PAINTING

A. Do not prime non-ferrous metals.

B. After fabrication, blast clean ferrous metals exposed in finished work, SSPC SP6. (Clean, brush, scrape and remove oil, grease and extraneous matter from other surfaces, solvent clean to SSPC SP1).

C. After cleaning mask edges with duct tape to be field welded.

D. Prime Finish: After cleaning, except where specified otherwise, apply full, smooth priming coat in shop. Work paint into corners and open spaces and deliver to Site with primer undamaged and to satisfaction of Consultant. (Commercial blast cleaned surfaces are to be primed immediately).

2.5 HOT DIP GALVANIZING

A. After fabrication, hot dipped galvanize specific miscellaneous steel items indicated on Drawings and/or called for herein.

B. Straighten shapes and assemblies true to line and plane after galvanizing.

C. Repair damaged galvanized surfaces with brush or spray-applied anti-corrosion coating containing 92-95% zinc, in accordance with Manufacturer's printed directions.

D. Galvanize Following: Members exposed to elements when in final location; members embedded on exterior side of exterior walls; members imbedded in concrete; members specified in this Section or indicated on Drawings.

E. Hot-dip galvanize steel members specified to be galvanized except galvanized sheet steel, in accordance with CAN/CSA-G164-M and requirements of following ASTM Standards, with minimum coating weights or thicknesses as specified.

F. Rolled, Pressed and Forged Steel Shapes, Plates, Bars and Strips: ASTM A123; average weight of zinc coating per m^2 (sq ft) of actual surface, less than 6 mm (1/4") thickness members, 605 g (2 oz); 6 mm (1/4") or heavier thickness members, 710 g (2.3 oz).

G. Iron and Steel Hardware: ASTM A153; minimum weight of zinc coating, in (ounces per sq ft) of surface shall be in accordance with Table 1 of ASTM A153, for various classes of materials used on work.

H. Galvanized Steel Sheet to ASTM A 653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated by the Hot-Dip Process, Coating Designation Z275 (G90), minimized spangle and chemically treated. Weight of zinc coating, 275 g/m^2 (1-1/4 oz per sq ft) on both sides of sheet.

PART 3. EXECUTION

3.1 INSTALLATION

A. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, to reviewed Shop Drawings, free from distortion or defects detrimental to appearance and performance.

B. Insulate metals where necessary to prevent corrosion due to contact between dissimilar metals and between metals and masonry, concrete or plaster. Use bituminous paint, butyl tape, building paper or other approved means.

C. Supply instructions, templates, and, if necessary, supervise installation of fastenings or accessories requiring to be built-in by other Sections of work.

D. After erection and installation, clean work and apply field touch of same formula as shop coat primer to damaged or unpainted surface of shop primed material. Work primer into joints, crevices, interstices and open spaces.

E. Weld as specified herein.

3.2 ALUMINUM ACCESS HATCHES

A. The access covers shall be constructed of aluminum checker plate to the sizes shown on the Drawings.

B. The frames and supports shall be constructed of aluminum angle, sizes as shown, set true and level with well fitted mitred corners neatly welded; all as shown on the Drawings.

C. The Contractor shall install anchor bars to anchor the frames. Shop Drawings, denoting the sizes and numbers of bars to be used, shall be submitted to the Consultant for review prior to fabrication and installation of the materials.

D. The hinges used shall be of adequate strength, installed as required.

E. Provide a hold open arm; spring assist mechanism channel frame with 30 mm drainage coupling and tamperproof bolts.

F. Lifting mechanisms shall be provided with compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing and shall not be affected by temperature. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be Type 316 Stainless Steel. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space. Cover shall be equipped with a spring latch with interior and exterior turn handles.

G. Plates shall be braced as required using welded ribs to improve rigidity. The plate and ribs shall be designed so that the maximum deflection of the plate does not exceed the lower of $1/240^{th}$ of the span, or a maximum of 12 mm when subjected to a load of $12kN/m^2$.

H. Lifting handle complete with underside box and shall be provided with all access covers.

I. Covers shall be with lock device as shown on Drawings, fabricated from aluminum angles complete with heavy duty padlocks with tough thermoplastic jacket as supplied by Hampton Lock Co. Inc.

J. Access hatches frame and covers shall be supplied by MSU Mississauga or reviewed equivalent.

3.3 ALUMINUM HANDRAIL AND GUARDRAILS

A. Pipe railing components shall be welded connection joints suitable for interior use.

B. Provide sample, no later than 30 days after award of contract, showing a typical stair post installation complete with rails, base and one bend. Show welded and non-welded joints.

C. Post spacing shall be 1250 mm maximum spacing or as shown on the Drawings. The post and rails shall be 6063 aluminum pipe 38 mm. Schedule 40 and the top and other rails shall be 43 mm. Schedule 40 pipe. Suitable expansion sleeves shall be provided at or near each expansion joint in the structures and elsewhere with spacing not exceeding 7.6 m. Each expansion piece will be installed to allow at least 12 mm expansion and contraction. Posts shall be connected to floor by means of a round, rectangular or square base flange, wherever possible use side mounting flange, slope base flange or side mount angle, refer to the Drawings to determine what connections would suit. Toe boards 125 mm high to be used as required by the OBC, and where indicated on the Contract Drawings.

D. The distance to edge of platform shall be a minimum 75 mm from centreline of post, or as shown on the Drawings. Provide wall brackets, returns and end caps as required, and detailed.

E. The pipe railing shall conform to the loading requirements of the OBC Code.

F. All exposed piping components shall have a brushed finish with a 0.7 mil clear anodized finish.

3.4 ALUMINUM GRATING

A. Grating and bearing plates shall be constructed of Aluminum Type 6351-T6.

B. Grating shall be capable of supporting a minimum live load of 12kN/m² with maximum allowable deflection of 1/240 of the span. Provide extra framing around all openings.

C. Interconnect bearing bars in each panel at ends with banding bars connected to each bearing bar. Banding bars to be of the same height as the main bearing bar and with minimum thickness of 4.8 mm. Finish all openings in the grating which require cutting of more than three main bars, or a side and end bar, in the same manner as the ends of the grating panels. Fabricate the panels in such a manner that where a number of panels are to be laid side by side the carrier or spacer bars, running at right angles to the bearing bars, line up so as to preserve a continuous appearance.

D. Clip panels together with sufficient purpose made clips to prevent differential movement panel to panel when subject to moving loads.

3.5 CONNECTIONS

A. Main member connections shall be welded or bolted with high tensile strength bolts and double angle connections as listed in CISC Standard Practice for Structural Steel.

B. Bolted connections.

C. High strength bolted connections shall be bearing type using M20 (3/4") bolts conforming to ASTM A325M. Secondary members may be bolted with machine bolts.

D. Perform high tensile bolted connections in accordance with CAN/CSA-S16.1-M and be field tested.

E. Accurately space holes of size 1.6 mm (1/16") larger than nominal diameter of bolt. High tensile bolt connections shall be bearing (friction) type unless noted otherwise.

F. Provide compressor or electrical equipment capable of supplying and maintaining required pressure at wrench.

G. Make connections without use of erection bolts, some high tensile bolts will serve that purpose.

H. Nuts or bolts, except high tensile bolts, shall be prevented from becoming loose by burring bolt thread, by welding or by lock washers or lock nuts.

3.6 FASTENERS

A. Supply fasteners, anchors and accessories required for erection of work of this Section. Ensure items occurring on or in exterior wall or slab are hot dipped galvanized.

B. In concrete and masonry, use epoxy injection anchor for vibration and heavy loads, and where anchors may be close to edge or close to adjacent anchors.

C. Use sleeve anchors in hollow block and brick for light static loads.

D. Use ULC approved drop-in anchors for pipe and sprinkler systems suspended from concrete ceiling.

E. Use wedge anchors for light to medium static loads in concrete.

F. Use concrete screws for light static loads in concrete, block and masonry.

G. Use heavy load expansion anchors for heavy static, vibratory or impact loading in concrete.

3.7 WELDING

A. Welds on exterior work shall be continuous to provide proper weathering.

B. Take necessary safety precautions in accordance with CSA Standards when the welding is carried out in cold weather.

C. No welding of galvanized products is allowed.

3.8 SCHEDULES

A. General: Provide miscellaneous metal work indicated on Drawings and not included in work of other Sections in addition to items listed below.

B. Where items are required to be built into masonry, concrete or other work provide such items to respective Sections with all anchors and accessories for building in.

C. Itemized List: Provide following metal work unless specifically designated to be supplied only. List supplied herein is not necessarily complete and shall be augmented by thorough inspection of Drawings and all other requirements to complete Work.
Each item shall be as indicated on Drawings and as detailed on reviewed Shop Drawings.

D. Lateral Supports for Masonry Partitions: Steel angles 100 mm x 100 mm x 150 mm long (4" x 4" x 6") to underside of structure to provide lateral support for masonry partitions where they are carried up to underside of structures above finished ceilings and are not braced laterally by wedge and grout.

1. Place angle each side of partition and secure to structure above at 1200 mm spacings.

E. Bollards: Fabricate bollards of Schedule 40 galvanized pipe of sizes indicated with exposed ends ground smooth, sharp edges rounded off.

1. Provide with steel lugs for bolting to concrete footing.

2. Coordinate with Section 03300 – Cast-In-Place Concrete, in setting in place.

F. Support Framing Systems: Provide fabricated steel support for ceiling mounted toilet partitions, roof mounted safety anchors, moprack support, shower and mud room bench supports, washroom vanities, shelving, counter and other framing systems indicated, complete with anchors, brackets, sleeves, screws and incidentals required to complete installations.

1. Secure to wall and/or floor in semi concealed manner to support vanities greater than 2 m (6') in length or where end of vanity is not supported by abutting wall.

G. Aluminum checker plate shall be raised pattern stock, minimum thickness 6.0 mm, with all edges planed and ground. Plates shall be braced as required using welded ribs to improve rigidity. The plate and ribs shall be designed so that the maximum deflection of the plate does not exceed the lower of 1/240th of the span, or a maximum of 12 mm when subjected to a minimum load of 12 kN/m^2.

H. Hangers for Light Enclosures: Supply metal light hanger supports to Carpentry and Millwork for installation.

I. Sheet Steel Covers: Supply sheet steel covers fabricated of minimum 0.9 mm (1/32") thick galvanized steel sheet to Division 15 – Mechanical and Division 16 – Electrical requiring covers over temporarily unused sleeves in vertical plane.

1. Openings in slabs and openings in other horizontal planes shall be structurally sound to suit application and size of opening and shall be in conformance with OBC requirements.

J. Provide Steel Sections which are not indicated and identified on Structural Drawings, unless noted to be supplied by another Section of Specifications.

K. Provide such items complete with anchors, brackets, bearing plates and other accessories required for installation.

L. Where Steel Sections are required to be built into masonry or concrete, supply such members to respective trades for building in.

M. Work shall include, without being limited to Steel lintels (loose), including those required over masonry openings and recesses for mechanical or electrical services.

N. Where lintels cannot be supported on masonry, provide plates anchored flush into column or wall and weld lintel thereto to satisfaction of Consultant.

O. Roof Framing: Steel plates, sheet steel backing plates, metal supports for parapet flashing, angles and channels to provide framing at cants, curbs and parapets, galvanized after fabrication.

P. Miscellaneous Items: Provide items complete with anchors, brackets, sleeves, screws and other incidentals required and as detailed.

1. Where steel items or supports are required to be built into masonry or concrete, supply such members to respective trades.

END OF SECTION

DIVISION 7

THERMAL AND MOISTURE PROTECTION

INDEX

PART 1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. All Sections of Division 1.

B. Section 03300 – Cast-In-Place Concrete.

C. Section 03420 – Precast Concrete Chambers.

D. Section 03730 – Concrete Repairs and Restoration.

E. Section 07211 – Board Insultation.

1.2 INTENT

A. This Section covers the following works:

1. Waterproofing membrane on exterior surfaces of water-retaining concrete structures/chambers and where indicated on Contract Drawings.

2. Waterproofing and protective coating on interior surfaces of water-retaining concrete structures/chambers and where indicated on Contract Drawings.

3. Dampproofing to the exterior surfaces of electrical vault chamber, maintenance holes, and process pipes where indicated on the Contract Drawings or Specifications.

1.3 APPLICATOR

A. All Work shall be performed by an experienced, competent waterproofing applicator, with at least of five (5) years experience, licensed and/or approved by the Product's Manufacturer.

B. Submit the Manufacturer's certification of this approval along with a list of similar projects and references where the proposed Subcontractor has installed the same waterproofing/dampproofing systems.

C. All installation equipment and procedures shall be approved by the Product's Manufacturer. Submit proof of this approval.

1.4 GUARANTEE/WARRANTY

A. Select the waterproofing system compatible with and suitable for the given conditions and long-term requirements of the Contract.

B. Provide completely watertight work with no leakage through or around the waterproofing.

C. Furnish a written, single source guarantee/warranty covering the waterproofing materials and workmanship for a period of three (3) years from the Date of Total Performance of the Work, and be responsible for making good, at no cost to the Owner, any and all defects due to the failure of the waterproofing materials, workmanship or overall performance.

1.5 WATERPROOFING SYSTEM APPLICATION

A. Apply waterproofing system to protect dry areas from wet areas, below grade areas, below liquid level areas and other areas identified on the Contract Documents.

B. Utilize any one of the systems listed in this section. Do not mix systems. Provide a complete membrane waterproofing system from one Manufacturer for locations as indicated on the Contract Drawings.

C. Where waterproofing system is discontinued, extend waterproofing 1.0 metre beyond the required location unless otherwise directed by the Consultant.

D. Confirm the locations and details with the Consultant prior to proceeding with the application of selected waterproofing system.

1.6 DAMPPROOFING SYSTEM APPLICATION

A. Apply dampproofing to the exterior surface of maintenance holes, precast catch basins, process pipes and other intended below grade concrete elements where indicated on the Contract Documents.

1.7 SUBMITTALS

A. Submit Shop Drawings for review in accordance with Section 01330 – Submittals.

B. The Shop Drawing submission shall include, but not be limited to, the following:

1. Product Manufacturer's written approval of the proposed waterproofing Subcontractor.

2. List of reference contacts and similar projects completed by the proposed Subcontractor using the same waterproofing products.

3. Product samples and Manufacturer's technical literature for materials and application procedures.

C. Submit details of the proposed waterproofing systems for each area. Include material data sheets, layer sequence and thickness, surface preparation and acceptance criteria, and protection criteria.

D. Submit the Waterproofing Manufacturer's instructions and details for application, membrane thickness, number of layers, cant beads, protection board, expansion joints, cracks, reinforcing sheets, pipe protrusions, lapping details, termination details, etc.

E. During the course of the Contract, immediately prior to commencing the work in each area, submit a Letter of Acceptance for the concrete surfaces to be waterproofed, signed by the Applicator's Authorized Representative.

F. The Product Manufacturer's Representative is to inspect the Waterproofing Subcontractor's work on a regular basis and submit inspection reports to the Consultant.

G. Upon Total Performance of the Work, submit a three (3) year, single source, 100% labour and materials guarantee/warranty covering materials, workmanship and long term performance of the overall waterproofing system.

H. Submit Operation and Maintenance (O&M) Data for all equipment in this Section in accordance with Section 01330 –Submittals.

1.8 QUALITY CONTROL

A. Refer to Section 01010 – General Requirements.

B. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

C. Certificates: Product certificates signed by Manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

D. Convene pre-installation meeting to:

1. Verify project requirements.

2. Review installation and substrate conditions.

3. Co-ordinate with other building subtrades.

4. Review Manufacturer's installation instructions and warranty requirements.

E. Health and Safety Requirements: Do construction occupational health and safety as per Section 01351 – Health and Safety.

PART 2. PRODUCTS

2.1 WATERPROOFING SYSTEM MATERIALS

A. Waterproofing membrane system on exterior concrete surfaces:

1. Elasto-Seal 790-11 system as Manufactured by Bakor Inc.

    a. Provide a complete system from one Manufacturer, meeting the Contract requirements.

    b. Primer – 930-18 or 910-01.

    c. Membrane – Elasto-Seal 790 – 11 1 layer 4.5 mm thick on vertical surfaces and 2 layers of 4.5 mm each on horizontal surfaces.

    d. Reinforcement/Flashing – Polyester fabric by Bakor or 990 –25 elastomeric sheet.

    e. Protect with 3 mm thick protection boards on walls and 6 mm thick protection boards on buried roofs.

2. TREMproof 6100 system as Manufactured by Tremco.

    a. Provide a complete system from one Manufacturer, meeting the Contract requirements.

    b. Primer PQ 6109.

    c. Membrane – PPQ 6100 – 1 layer 4.5 mm thick on vertical surfaces and 2 layers of 4.5 mm each on horizontal surfaces.

    d. Reinforcement – spun bonded fabric – PQ 2016 – elastomeric – butyl rubber – PQ 2047 or PQ 2063.

    e. Protect with 3 mm thick protection boards on walls and 6 mm thick protection boards on buried roofs.

3. For underside of base slab, blindsided walls and on exposed walls, use TREMproof Amphibia and TREMproof 560A with associated installation accessories and protection/drainage sheets as per Manufacturer's instructions.

B. Waterproofing Protective System on Interior Concrete Surfaces:

1. Cem-Kote Flex CR with Cem-Kote Barrier Cote 100, by W.R. Meadows of Canada.
2. Sika Top Seal 107CA by Sika Canada Inc.
3. Mapelastic by Mapei Canada.

2.2 DAMPPROOFING SYSTEM MATERIALS

A. Use a Mineral Colloid Asphalt Emulsion conforming to CGSB Standard 37GP2.

B. Two brush coats at a rate of 1 L per 2 square metre per coat.

PART 3. EXECUTION

3.1 GENERAL

A. Deliver materials to the site in factory sealed containers with the Manufacturer's identification of each package.

B. Ensure work areas are dry and clean during the work of this Section.

C. Store materials in a manner to prevent damage or deterioration.

3.2 CONCRETE SURFACE PREPARATION, INSPECTION AND CERTIFICATION

A. As an initial step, clean all surfaces to be waterproofed/dampproofed of any and all deleterious material.

B. Inspect all subject surfaces to identify imperfections including, but not limited to, uneven surfaces, joints, cracks, honeycombing, spalls, delaminated areas, previous waterproofing materials, exposed reinforcing steel, or any other existing conditions that may affect the performance of the new waterproofing/dampproofing system.

C. Repair cracks in concrete using polyurethane or epoxy injection. After injection, remove any related coatings or injection nipples and prepare the surfaces affected.

D. Repair other surface imperfections and surfaces of cracks by chipping out and filling with repair mortar to the satisfaction of the Consultant and Waterproofing/Dampproofing Materials Manufacturer and Applicator, prior to beginning final surface preparation steps.

E. Blast clean all surfaces to a dry, roughened texture using approved equipment, materials and methods, while adhering to the Waterproofing/Dampproofing Manufacturer's requirements and environmental considerations.

F. The Waterproofing/Dampproofing Manufacturer's Authorized Agent is to inspect surfaces to be waterproofed with the Consultant and the Waterproofing Subcontractor. Provide to the Consultant a written certification from the Waterproofing Manufacturer that the surfaces are acceptable for the application of the waterproofing system, and that the proposed waterproofing system is appropriate for the location and required service. Do not apply any waterproofing until the Consultant receives the written certification from the Manufacturer.

G. Where required by the Applicator or Manufacturer, prepare surfaces by parging the concrete with cementitious material to a trowelled finish as approved by the Applicator.

3.3 PRE-TREATMENT AND DETAILING

A. Inspect all concrete surfaces and confirm in writing the surfaces are cleaned and reviewed and accepted by the Product's Manufacturer.

B. Pre-treat repaired areas with a layer of fibre-reinforced coating as recommended by the Waterproofing Manufacturer.

C. Provide cants, reglets, and edge preparations as per the details on Product Manufacturer's Shop Drawings.

D. Apply primers as recommended by the Product's Manufacturer.

3.4 APPLICATION OF WATERPROOFING SYSTEM

A. Comply with the Manufacturer's recommended materials and procedures, as submitted and reviewed.

B. Conform to the Waterproofing Manufacturer's instructions and details for surface preparation, application, membrane thickness, number of layers, cant beads, protection board, expansion joints, cracks, reinforcing sheets, bonding of layers, bonding of wall waterproofing to waterproofing on skim slabs, etc.

C. Schedule the work to allow 28 Days curing for new concrete prior to waterproofing.

D. Apply waterproofing only when atmospheric conditions are suitable. Do not apply during rain or when temperatures are below/above the specified limit in the Product Data Sheet. Maintain material and substrate temperatures and humidity within the limits recommended by the Product's Manufacturer. Provide suitable enclosures of areas to be waterproofed if necessary to satisfy the work condition requirements.

E. Lap joints in waterproofing in accordance with the Manufacturer's instructions.

F. Cure membrane in accordance with the Manufacturer's instructions.

G. Use special designed spray machines where recommended by the Product's Manufacturer.

3.5 APPLICATION OF DAMPPROOFING SYSTEM

A. Comply with the Manufacturer's recommended materials and procedures, as submitted and reviewed.

B. Clean surfaces of water, frost, dust, oil, grease or other foreign matters.

C. Examine the surfaces to be dampproofed and repair unsatisfactory areas.

D. Apply layers of coats of the dampproofing material at a rate specified by Product's Manufacturer.

3.6 PROTECTION OF WATERPROOFING AND DAMPPROOFING SYSTEMS

A. Determine, from the Product's Manufacturer prior to construction, protection measures required to protect applied materials from damage.

B. Provide and use protection boards, as required by the Product's Manufacturer.

C. Inspect installed materials for any damages before any other operations. Repair any damages found per Product Manufacturer's instructions.

D. Do not backfill against or work next to installed materials until full protection measures, satisfactory to the Product's Manufacturer, are in place.

3.7 CLEAN-UP

A. Promptly, as the work proceeds and upon completion, clean-up and remove from the site, all rubbish and surplus material resulting from the work of this Section.

END OF SECTION

PART 1. GENERAL

1.1 SUMMARY

A. All conditions of the Contract apply to the work of this Section.

B. Report in writing to the General Contractor any defects of surfaces or work prepared by other Trades which affect the quality or dimensions of this Contractor's work. Commencement of this Contractor's work shall imply complete acceptance of all work by other Trades.

1.2 INTENT

A. Provide all articles, labour, materials, equipment and transportation, hoisting and incidentals noted, specified or required to complete the work of this Section.

1.3 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. All Sections of Division 1.

B. Sections 03300 – Cast-In Place Concrete.

C. Sections 03420 – Precast Concrete Chambers.

D. Sections 07100 – Waterproofing and Dampproofing.

1.4 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. ASTM C 208-95(2001), Specification for Cellulosic Fiber Insulating Board.

2. ASTM C 591-01, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

3. ASTM C 612-04, Standard Specification for Mineral Fibre Block and Board Thermal Insulation.

4. ASTM C 726-05, Standard Specification for Mineral Fiber Roof Insulation Board.

5. ASTM C 728-05, Standard Specification for Perlite Thermal Insulation Board.

6. ASTM C 1126-04, Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.

7. ASTM C 1289-05a, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.

8. ASTM E 96/E 96M-05, Standard Test Methods for Water Vapour Transmission of Materials.

B. Canadian Gas Association (CGA):

1. CAN/CGA-B149.1-05, Natural Gas and Propane Installation Code Handbook.

2. CAN/CGA-B149.2-05, Propane Storage and Handling Code.

C. Canadian General Standards Board (CGSB):

1. CGSB 71-GP-24M-77(R1983), Adhesive, Flexible, for Bonding Cellular polystyrene Insulation.

D. Underwriters Laboratories of Canada (ULC):

1. CAN/ULC-S604-M91, Standard for Type A Chimneys.

2. CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.

3. CAN/ULC-S702-97, Standard for Thermal Insulation, Mineral Fibre, for Buildings.

4. CAN/ULC-S704-03, Standard for Thermal Insulation Polyurethane and Polyisocyanurate, Boards, Faced.

E. Health Canada/Workplace Hazardous Materials Information System (WHMIS):

1. Safety Data Sheets (SDS).

1.5 SUBMITTALS

A. Submit Shop Drawings for review in accordance with Section 01330 – Submittals.

B. Product Data:

1. Submit Manufacturer's printed product literature, specifications and data sheet.

2. Submit WHMIS SDS – Safety Data Sheets. Indicate VOC's insulation products and adhesives.

C. Manufacturer's Instructions:

1. Submit Manufacturer's installation instructions.

D. Submit Operation and Maintenance (O&M) Data for all equipment in this Section in accordance with Section 01330 –Submittals.

1.6 QUALITY CONTROL

A. Refer to Section 01400 – Quality Requirements.

B. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

C. Certificates: Product certificates signed by Manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

D. Convene pre-installation meeting to:

1. Verify project requirements.

2. Review installation and substrate conditions.

3. Co-ordinate with other building subtrades.

4. Review Manufacturer's installation instructions and warranty requirements.

E. Health and Safety Requirements: Do construction occupational health and safety as per Section 01351 – Health and Safety.

PART 2. PRODUCTS

2.1 INSULTATION

A. Expanded Polystyrene (EPS) to CAN/ULC-C701:

1. Type: 3 and 4.
2. Thickness: As indicated.
3. Insulation Value: As indicated.
4. Compressive Strength: 210 kPa.
5. Edges: Shiplapped.
6. Product: Dow SM, Cavitymate or Celfort 300.

2.2 ADHESIVE

A. As recommended by the Manufacturer for location and service conditions.

B. Type A: Synthetic rubber base, solvent type, trowel consistency for use with glass fibre rigid insulation.

C. Type B: CGSB 71-GP-24M.

D. Type C: Vapour barrier type, medium trowel consistency.

E. Impaling Pins: Stainless steel impaling pins complete with plastic retaining washers for use in temporarily securing insulation to vertical underground surfaces until backfill installed, and as otherwise indicated.

F. Insulation Fasteners: Impale type, perforated 50 mm x 50 mm cold rolled steel adhesive back, spindle of length to suit insulation plus 25 mm with speed washers.

G. Insulation Adhesive, where indicated and all unsupported insulation edges.

2.3 ACCESSORIES

A. Insulation clips: impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self-locking type.

PART 3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with Manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions and data sheets.

3.2 WORKMANSHIP

A. Install insulation after building substrate materials are dry.

B. Install insulation to maintain continuity of thermal protection to building elements and spaces.

C. Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around access hatches and other protrusions.

D. Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN4-S604 Type A Chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 Type B and L Vents.

E. Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.

F. Offset both vertical and horizontal joints in multiple layer applications.

G. Do not enclose insulation until it has been inspected and approved by Consultant.

3.3 EXAMINATION

A. Examine substrates and immediately inform Consultant in writing of defects.

B. Prior to commencement of work ensure:

1. Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

3.4 RIGID INSULATION INSTALLATION

A. Apply Type A adhesive to insulation board at rate of 1 L/m^2 by notched trowel with 5 mm notches at 10 mm oc or apply at rate of 0.35 L/m^2 by spot method with daubs 25 mm x 40 mm diameter x 25 mm high at 200 mm oc each way or by bead method with 8 mm diameter beads 350 mm oc.

B. Apply Type B adhesive to insulation board at a rate of 0.35 L/m^2 by spot method with daubs, 25 mm x 40 mm diameter x 25 mm high at 200 mm oc each way or by bead method with 8 mm diameter beads 350 mm oc.

C. Apply Type C adhesive to substrate material at rate of 3 L/m^2 3 mm thick, to achieve a continuous vapour retardant film. Butter edges of board for continuous seal.

D. Fix insulation clip type fasteners on substrate, 600 mm x 1200 mm board minimum. Impale insulation board on insulation clips, butting all joints firmly together and secure with washers, cut off spindles 3 mm beyond washer.

E. Leave insulation board joints unbonded over line of expansion and control joints. Bond a continuous 150 mm wide 6 mil polyethylene strip over joint using compatible adhesive prior to application of insulation.

F. Provide flexible insulation of equivalent thickness and thermal insulation to fit areas where application of rigid insulation is not possible to provide continuous coverage.

3.5 PERIMETER FOUNDATION INSULTATION

A. Install insulation boards vertically on outside face of perimeter foundation walls extending to min depth of 1200 mm below finished floor.

B. Under Concrete Floor Slab Insulation.

C. Lay insulation boards on level compacted fill extending a minimum of 1200 mm in from perimeter foundation wall.

3.6 BELOW EXTERIOR SLABS

A. Install Type 4 expanded polystyrene insulation at below exterior slab locations at all entrances as indicated on Drawings. Lay boards on level compacted fill.

3.7 CLEAN-UP

A. Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

DIVISION 9

FINISHES

INDEX

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 05500 – Metal Fabrications.

B. Division 11 – Equipment.

C. Division 15 – Mechanical.

D. Division 16 – Electrical.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A3960-05 – Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.

B. Canadian General Standards Board (CGSB):

1. CAN/CGSB-1.38-2000 – Interior Enamel Undercoater.
2. CAN/CGSB-1.57-2003 – Alkyd, Interior, Semi-gloss, Enamel.
3. CAN/CGSB-1.60-97 – Interior Alkyd Gloss Enamel.
4. CAN/CGSB-1.68-M91 – Solvent Type Primer-Sealer for Interior Walls.
5. CAN/CGSB-1.119-2000 – Primer-Sealer, Wall, Interior Latex Type.
6. CAN/CGSB-1.143-98 – Heat Resistant Aluminum Enamel, Silicone Alkyd.
7. CAN/CGSB-1.153-2000 – High Build, Gloss, Epoxy Coating.
8. CAN/CGSB-1.165-2004 – Cold Curing Epoxy Primer.
9. CAN/CGSB-1.188-2004 – Emulsion Type Filler Masonry Block.
10. CAN/CGSB-1.195-99 – Interior Semi-gloss Latex Paint.
11. CAN/CGSB-1.198-2001 – Cementitious Primer (for Galvanized Surfaces).
12. CAN/CGSB-1.202-2003 – Interior Low Gloss Alkyd Enamel.

13. CAN/CGSB-1.209-2003 – Low Sheen Latex Interior Paint.
14. CAN/CGSB-85.10-99 – Protective Coating for Metals.
15. CAN/CGSB-85-100-93 – Painting.
16. CAN/CGSB-1.146.99 – Cold Curing, Gloss Epoxy Coating.

C. Canadian Painting Contractors' Association (CPCA):

1. Painting Specifications Manual 21993.

D. Environmental Choice Program (ECP):

1. ECP-67-95 – Recycled Water-Borne Surface Coatings.
2. ECP-76-98 – Surface Coatings.

E. Environmental Protection Agency (EPA):

1. EPA-SW-846 – Test Methods for Evaluating Solid Wastes.

F. National Fire Code of Canada 1995.

1.3 PRODUCT DATA

A. Submit product data in accordance with Section 01330 – Submittals.

B. Submit full records of all products used. List each product in relation to finish formula and include the following:

1. Finish formula designation.
2. Product type and use.
3. CGSB number.
4. Manufacturer's product number.
5. Colour number.
6. Manufacturer's Safety Data Sheets (SDS).
7. Maximum VOC classification.
8. Eco-Logo certification.

C. Submit Manufacturer's application instructions for each product specified.

1.4 SAMPLES

A. Submit samples in accordance with Section 01330 – Submittals.

B. Submit full range of available colours where colour availability is restricted.

1.5 QUALITY ASSURANCE

A. Retain purchase orders, invoices and other documents to prove that all materials utilized in this Contract meet requirements of the Specifications. Produce documents when requested by Engineer.

B. Standard of Acceptance:

1. Walls: No defects visible from a distance of 1000 mm at 90 degrees to surface.

2. Ceilings: No defects visible from floor at 45 degrees to surface when viewed using final lighting source.

3. Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver and store materials in original containers, sealed, with labels intact.

B. Indicate on Containers or Wrappings:

1. Manufacturer's name and address.

2. Type of paint.

3. Compliance with applicable standard.

4. Colour number in accordance with established colour schedule.

C. Remove damaged, opened and rejected materials from site.

D. Provide and maintain dry, temperature controlled, secure storage.

E. Observe Manufacturer's recommendations for storage and handling.

F. Store materials and supplies away from heat generating devices.

G. Store materials and equipment in a well-ventilated area with temperature range to meet the Manufacturer's Specifications.

H. Store temperature sensitive products above minimum temperature as recommended by Manufacturer.

I. Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Engineer. After completion of operations, return areas to clean condition to approval of Engineer.

J. Provide minimum one (1) 9 kg dry chemical fire extinguisher adjacent to storage area.

K. Remove only in quantities required for same day use.

L. Fire Safety Requirements:

1. Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.

2. Handle, store, use and dispose of flammable combustible materials in accordance with the National Fire Code of Canada.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Environmental Choice Program:

1. Provide paint products certified to meet the requirements of the Environmental Choice Program, Department of the Environment.

2. Submit CSA Certification Reports that products proposed for use are certified under the Environmental Choice Program. Recycled water-borne surface coatings to be certified to ECP-67. All other surface coatings to be certified to ECP-76.

B. Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials.

C. Ventilation:

1. Contractor to provide continuous ventilation during and after application of paint. Run ventilation system 24 hours per day during installation. Provide continuous ventilation for seven (7) days after completion of application of paint.

D. Apply paint finishes only when temperature at location of installation can be satisfactorily maintained within Manufacturer's recommendations.

E. Substrate and ambient temperature must be within limits prescribed by Manufacturer to approval of Engineer.

F. Maintain minimum substrate and ambient air temperature of 5ºC for alkyd and 7ºC for latex paints. Maximum relative humidity 85%. Maintain supplemental heating until paint has cured sufficiently.

G. Provide temporary heating where permanent facilities are not available to maintain minimum recommended temperatures.

H. Apply paint finish only in areas where dust is no longer being generated by related construction operations, such that airborne particles will not affect the quality of the finished surface.

I. Apply paint only when surface to be painted is dry, properly cured and adequately prepared.

1.8 SCHEDULING

A. Submit work schedule for various stages of painting to Engineer for approval. Submit schedule minimum of two (2) working days in advance of proposed operations.

B. Obtain written authorization from Engineer for any changes in work schedule.

1.9 EXTRA MATERIALS

A. Submit maintenance materials in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. Submit one (1) four-litre can of each type and colour of finish coating. Identify colour and paint type in relation to established colour schedule and finish formula.

C. Deliver to Engineer and store where directed.

PART 2. PRODUCTS

2.1 MATERIALS

A. Qualified Products: Only paint materials listed on the CPCA Approved Products Lists are acceptable for use on this project.

B. Qualified Products: Only paint materials listed as Eco-Logo Approved Products are acceptable for use on this project.

C. Paint materials for each coating formula to be products of a single Manufacturer.

D. Low Odour Products: Whenever possible, select products exhibiting low odour characteristics. If two (2) products are otherwise equivalent, select the product with the lowest odour.

E. Water-Borne Surface Coatings must:

1. Meet or exceed all applicable Governmental and/or Industrial Safety and Performance Standards.

2. Manufactured and transported in such a manner that all steps of the process, including the disposal of waste products arising therefrom, will meet the requirements of all applicable Governmental Acts, By-laws and Regulations including, for facilities located in Canada, the Fisheries Act and the Canadian Environmental Protection Act (CEPA).

F. Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

G. Water-borne surface coatings and recycled water-borne surface coatings must have a flash point of 61ºC or greater.

H. Water-borne surface coatings and recycled water-borne surface coatings must contain information describing proper disposal methods within their packaging.

I. Recycled Water-Borne Surface Coatings must not contain:

1. Lead in excess of 600.0 ppm weight/weight total solids.

2. Mercury in excess of 50.0 ppm weight/weight total product.

3. Cadmium in excess of 1.0 ppm weight/weight total product.

4. Hexavalent chromium in excess of 3.0 ppm weight/weight total product.

5. Organochlorines or polychlorinated biphenyls (PCBS) in excess of 1.0 ppm weight/weight total product.

2.2 COLOURS

A. Engineer will provide colour schedule after Contract Award.

B. Colour schedule will be based upon the selection of five (5) base colours.

C. Selection of colours will be from Manufacturer's full range of colours.

D. Where specific products are available in a restricted range of colours, selection will be based on the limited range.

E. Perform all colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials allowed only with Engineer's written permission.

F. Second coat in a three-coat system to be tinted slightly lighter colour than topcoat to show visible difference between coats.

2.3 PAINT FINISHES

A. Formula 5 (Latex): For Concrete Walls and Ceilings apply:

1. One (1) Coat Latex Primer Sealer CAN/CGSB-1.119.

2. Two (2) Coats Semi-Gloss Enamel CAN/CGSB-1.195.

3. CPCA System Premium.

B. Formula 6 (Latex): For Concrete Block Walls apply:

1. One (1) Coat Latex Block Filler CAN/CGSB-1.188.

2. Two (2) Coats Semi-Gloss Enamel CAN/CGSB-1.195.

3. CPCA System INT-8-A, Premium. Finish Coat: Semi-Gloss.

C. Formula 8 (Latex): For Gypsum Board, Walls apply:

1. One (1) Coat Latex Primer-Sealer CAN/CGSB-1.119.

2. Two (2) Coats Low Gloss Enamel CAN/CGSB-1.209.

3. CPCA System INT-4-B, Premium. Finish Coat: Semi-Gloss.

D. Formula 15 (Alkyd): For Shop Primed Ferrous Metal Surfaces apply:

1. Touch-Up Shop Primer with Primer as provided by Fabricator.
2. One (1) Coat Marine Alkyd Metal Primer CGSB1-GP-48M.
3. Two (2) Coats Gloss Enamel CAN/CGSB-1.60-97.
4. CPCA System INT-12-A, Premium Custom. Finish Coat: Semi-Gloss.

E. Formula 16 (Epoxy): For Shop Primed Ferrous Metal Surfaces apply:

1. Touch-Up Shop Primer with Primer as provided by Fabricator.
2. One (1) Coat Cold Cured Epoxy Primer CAN/CGSB-1.165-2004 (Type 1).
3. Two (2) Coats Cold Cured Gloss Epoxy CAN/CGSB-1.146-99.
4. CPCA System INT-12-D, Premium.

F. Formula 17 (Alkyd): For Galvanized and Zinc Coated Metal apply:

1. One (1) Coat Cementitious Primer CAN/CGSB-1.198.
2. Two (2) Coats Semi-Gloss Enamel CAN/CGSB-1.57.
3. CPCA System INT-13-A, Premium. Finish Coat: Semi-Gloss.

G. Formula 21 (Alkyd): For Copper Piping and Fittings apply:

1. One (1) Coat Anti-Corrosive Vinyl Primer CAN/CGSB-1.122-99
2. Two (2) Coats Alkyd Exterior Gloss Enamel (Semi-Gloss Enamel) CAN/CGSB-1.57.
3. CPCA System INT-16-A, Premium. Finish Coat: Semi-Gloss.

PART 3. EXECUTION

3.1 GENERAL

A. Perform all painting operations in accordance with CAN/CGSB-85.100, except where specified otherwise.

B. Perform all painting operations in accordance with CPCA Painting Specifications Manual, except where specified otherwise.

C. Apply all paint materials in accordance with Paint Manufacturer's written application instructions.

3.2 PREPARATION

A. Remove electrical cover plates, light fixtures, surface hardware on doors, door stops, bath accessories and all other surface mounted fittings and fastenings prior to undertaking any painting operations. Store for re-installation after painting is completed.

B. Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

C. As painting operations progress, place "WET PAINT" signs in occupied areas to approval of Engineer.

3.3 PROTECTION

A. Protect existing building surfaces not to be painted from paint splatters, markings and other damage. If damaged, clean and restore such surfaces as directed by Engineer.

B. Cover or mask floors, windows and other ornamental hardware adjacent to areas being painted to prevent damage and to protect from paint drops and splatters. Use non-staining coverings.

C. Protect items that are permanently attached such as fire labels on doors and frames.

D. Protect factory-finished products and equipment.

3.4 EXISTING CONDITIONS

A. Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Engineer all damage, defects, unsatisfactory or unfavourable conditions before proceeding with work.

B. Investigate moisture content of surface to be painted, and report findings to Engineer. Do not proceed with work until conditions fall within acceptable range as recommended by Manufacturer.

C. Maximum moisture content as follows:

1. Plaster and Wallboard: 12%.

2. Masonry/Concrete: 12%.

3. Concrete Block/Brick: 12%.

4. Wood: 15%.

3.5 CLEANING

A. Clean all surfaces to be painted as follows:

1. Remove all dust, dirt and other surface debris by vacuuming and wiping with dry, clean cloths.

2. Wash surfaces with solution of T.S.P. bleach and clean, warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

3. Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

4. Allow surfaces to drain completely and allow to dry thoroughly.

5. To prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

6. Use trigger-operated spray nozzles for water hoses.

7. Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such organic solvents to clean-up water-based paints.

B. Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint or pre-treatment as soon as possible after cleaning and before deterioration occurs.

C. Sand existing surfaces with intact, smooth, high gloss coatings to provide adequate adhesion for new finishes.

3.6 SURFACE PREPARATION

A. Prepare stucco, brick, concrete masonry and concrete surfaces to CGSB 85.100-93.

B. Prepare plaster and wallboard surfaces to CGSB 85.100-93.

3.7 SURFACE PREPARATION – METAL

A. Clean new metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with the following:

1. Solvent Cleaning: SSPC-SP-1.
2. Hand Tool Cleaning: SSPC-SP-2.
3. Power Tool Cleaning: SSPC-SP-3.
4. Commercial Blast Cleaning: SSPC-SP-6.
5. Brush-off Blast Cleaning: SSPC-SP-7.

B. Clean existing metal surfaces to be repainted by removing loose, cracked, brittle or non-adherent paint, rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with following:

1. Scrape edges of old paint back to sound material. Where remaining paint is thick and sound, feather exposed edges.
2. Commercial blast clean rusted and bare metal surfaces where existing paint system has failed.
3. Solvent Cleaning: SSPC-SP-1.
4. Hand Tool Cleaning: SSPC-SP-2.
5. Power Tool Cleaning: SSPC-SP-3.
6. Commercial Blast Cleaning: SSPC-SP-6.

7. Brush-Off Blast Cleaning: SSPC-SP-7.

C. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes and vacuum cleaning.

D. Touch-up shop primer to CGSB 85-10-99 with primer as specified in applicable Section. Touch-up to include cleaning and painting of field connections, welds, rivets, nuts, washers, bolts and damaged or defective paint and rusted areas.

E. Prepare galvanized steel and zinc coated steel surfaces to CGSB 85.10-99.

F. Prepare copper and copper alloys surfaces to CGSB 85-GP-20M.

G. Prepare new steel surfaces exposed normally to dry conditions to CGSB 85.10-99.

H. Prepare previously painted steel surfaces exposed normally to dry conditions to CGSB 85.10-99.

I. Prepare steel surfaces exposed to industrial environments to CGSB 85.10-99.

J. Prepare steel surfaces exposed to water or high humidity levels to CGSB 85.10-99.

K. Do not apply paint until prepared surfaces have been accepted by Engineer.

3.8 MIXING PAINT

A. Mix ingredients in container before and during use and ensure breaking-up of lumps, complete dispersion of settled pigment and uniform composition.

B. Thin paint for spraying according to Manufacturer's instructions. If directions are not on container, obtain instructions in writing from Manufacturer and provide copy of instructions to Engineer.

C. Do not use kerosene or any such organic solvents to thin water-based paints.

3.9 APPLICATION

A. Method of application to be as approved by Engineer. Apply paint by brush, roller, air sprayer or airless sprayer. Conform to Manufacturer's application instructions unless specified otherwise.

B. Brush Application:

1. Work paint into cracks, crevices and corners. Paint surfaces not accessible to brushes by spray, daubers or sheepskins.

2. Brush out runs and sags.

3. Remove runs, sags and brush marks from finished work and repaint.

C. Spray Application:

1. Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied and equipped with suitable pressure regulators and gauges.

2. Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

3. Apply paint in a uniform layer, with overlapping at edges of spray pattern.

4. Brush out immediately all runs and sags.

5. Use brushes to work paint into cracks, crevices and places that are not adequately painted by spray.

D. Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access and only when specifically authorized by Engineer.

E. Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

F. Allow surfaces to dry and properly cure, after cleaning and between subsequent coats, for minimum time period, as recommended by Manufacturer.

G. Sand and dust between each coat to remove visible defects.

H. Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

3.10 MECHANICAL ELECTRICAL EQUIPMENT

A. In finished areas paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment. Colour and texture to match adjacent surfaces, except as noted otherwise.

B. Touch-up scratches and marks on factory-painted finishes and equipment with paint as supplied by Manufacturer of equipment.

C. Do not paint over nameplates.

D. Paint disconnect switches for fire alarm system and exit light systems in Red enamel.

E. Paint all fire protection piping Red.

F. Paint all-natural gas piping Yellow.

G. Paint both sides and edges of backboards for telephone and electrical equipment before installation. Leave equipment in original finish, except for touch-up, as required and paint conduits, mounting accessories and other unfinished items.

3.11 FIELD QUALITY CONTROL

A. Field inspection of painting operations to be carried out by independent inspection firm as designated by Engineer.

B. Advise Engineer when each applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

C. Cooperate with inspection firm and provide access to all areas of the work.

3.12 RESTORATION

A. Clean and re-install all hardware items that were removed before undertaking painting operations.

B. Remove protective coverings and warning signs as soon as practical after operations cease.

C. Remove paint splashings on exposed surfaces that were not painted. Remove smears and splatter immediately as operations progress, using compatible solvent.

D. Protect freshly completed surfaces from paint droppings and dust to approval of Engineer. Avoid scuffing newly applied paint.

E. Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Engineer.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 05500 – Metal Fabrications.

B. Division 11 – Equipment.

C. Division 15 – Mechanical.

D. Division 16 – Electrical.

1.2 REFERENCES

A. Canadian General Standards Board (CGSB):

1. CAN/CGSB-1.40-97 – Anti-corrosive Structural Steel Alkyd Primer.
2. CGSB1-GP-48M-89 – Primer, Marine, for Steel.
3. CAN/CGSB-1.59-97 – Alkyd, Exterior Gloss Enamel.
4. CGSB 1.61-2004 – Exterior and Interior Marine Alkyd Enamel.
5. CAN/CGSB-1.69-98 – Aluminum Paint.
6. CAN/CGSB-1.132-M90 – Zinc Chromate Primer, Low Moisture Sensitivity.
7. CAN/CGSB-1.143-98 – Heat Resistant Aluminum Enamel, Silicone Alkyd.
8. CAN/CGSB-1.153-2000 – High Build, Gloss, Epoxy Coating.
9. CAN/CGSB-1.165-2004 – Cold Curing Epoxy Primer.
10. CAN/CGSB-1.198-2001 – Cementitious Primer (for Galvanized Surfaces).
11. CAN/CGSB-85.10-99 – Protective Coating for Metals.
12. CAN/CGSB-85.100-93 – Painting.
13. CAN/CGSB-1.138-97 – Exterior Latex Flat Paint.
14. CAN/CGSB-1.146-99 – Cold Curing, Gloss Epoxy Coating.

B. Canadian Painting Contractors' Architectural (CPCA):

1. Painting Specifications Manual 1003.

C. National Fire Code of Canada, Latest Edition.

D. Steel Structures Painting Council (SSPC):

1. Systems and Specifications Manual 1989.

1.3 PRODUCT DATA

A. Submit product data in accordance with Section 01330 – Submittals.

B. Submit full records of all products used. List each product in relation to finish formula and include the following:

1. Finish formula designation.
2. Product type and use.
3. CGSB number.
4. Manufacturer's product number.
5. Colour number.
6. Manufacturer's Safety Data Sheets (SDS).
7. Maximum VOC classification.
8. Eco-Logo Certification.

C. Submit Manufacturer's installation application instructions for each product specified.

1.4 SAMPLES

A. Submit samples in accordance with Section 01330 – Submittals.

B. Submit full range of available colours where colour availability is restricted.

1.5 QUALITY ASSURANCE

A. Retain purchase orders, invoices and other documents to prove that all materials utilized in this Contract meet requirements of the Specifications. Produce documents when requested by Engineer.

B. Final coat to exhibit uniformity of colour and texture as well as uniformity of sheen across full surface area.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver and store materials in original containers, sealed, with labels intact.

B. Indicate on containers or wrappings:

1. Manufacturer's name and address.
2. Type of paint.
3. Compliance with applicable standard.
4. Colour number in accordance with established colour schedule.

C. Remove damaged, opened and rejected materials from site.

D. Provide and maintain dry, temperature controlled, weatherproof, secure storage.

E. Observe Manufacturer's recommendations for storage and handling.

F. Store materials and supplies away from heat generating devices.

G. Store materials and equipment in a well-ventilated area with temperature range to meet the Manufacturer's Specifications.

H. Store temperature-sensitive products above minimum temperature, as recommended by Manufacturer.

I. Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Engineer. After completion of operations, return areas to clean condition to approval of Engineer.

J. Provide minimum one (1) 9 kg dry chemical fire extinguisher adjacent to storage area.

K. Remove only in quantities required for same day use.

L. Fire Safety Requirements:

1. Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
2. Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Environment Choice Program:

1. Provide paint products certified to meet the requirements of the Environmental Choice Program, Department of the Environment.

B. Safety: Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage and disposal of hazardous materials.

C. Apply paint finishes only when conditions forecast for entire period of application fall within Manufacturer's recommendations.

D. Where surface to be painted is not under cover, do not apply paint when:

1. Substrate and ambient air temperature is below 5ºC for alkyd and 7ºC for latex paints or when temperature is expected to drop to 0ºC before paint has thoroughly cured.

2. Substrate and ambient air temperature are expected to fall outside limits prescribed by Manufacturer.

3. Temperature of surface is over 50ºC unless paint is specifically formulated for application at high temperatures.

4. Rain or snow is forecast to occur before paint has thoroughly cured; it is foggy, misty, raining or snowing at site; relative humidity is above 85%.

5. Surface to be painted is wet, damp or frosted.

6. Previous coat is not dry.

E. Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by Manufacturer. Protect until paint is dry or until weather conditions are suitable.

F. Apply paint finish only when dust is no longer being generated by related construction operations or when wind conditions are such that airborne particles will not affect the quality of the finished surface.

G. Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.

H. Remove paint from areas that have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

1.8 SCHEDULING OF WORK

A. Submit work schedule for various stages of painting to Engineer for approval. Submit schedule minimum of 48 hours in advance of proposed operations.

B. Obtain written authorization from Engineer for any changes in work schedule.

1.9 EXTRA MATERIALS

A. Submit maintenance materials in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. Submit one (1) 4-litre can of each type of colour of coating. Identify colour and paint type in relation to established colour schedule and finish formula.

C. Deliver to Engineer and store where directed.

PART 2. PRODUCTS

2.1 MATERIALS

A. Qualified Products: Only paint materials listed on the CGSB Qualified Products List Eco-Logo Approved Products are acceptable for use on this project.

B. Qualified Products: Only paint materials listed on the CPCA Approved Product Lists are acceptable for use on this project.

C. Water-Borne Surface Coatings must:

1. Meet or exceed all applicable Government and/or Industrial Safety and Performance Standards.

2. Be manufactured and transported in such a manner that all steps of the process, including the disposal of waste products arising therefrom, will meet the requirements of all applicable Governmental Acts, By-laws and Regulations including, for facilities located in Canada, the Fisheries Act and the Canadian Environmental Protection Act (CEPA).

D. Water-borne surface coatings must not be formulated or manufactured with aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

E. Water-borne surface coatings and recycled water-borne surface coatings must have a flash point of 61ºC or greater.

F. Water-borne surface coatings and recycled water-borne surface coatings must contain information describing proper disposal methods within their packaging.

G. Recycled Water-Borne Surface Coatings must not contain:

1. Lead in excess of 600.0 ppm weight/weight total solids.
2. Mercury in excess of 50.0 ppm weight/weight total product.
3. Cadmium in excess of 1.0 ppm weight/weight total product.
4. Hexavalent chromium in excess of 3.0 ppm weight/weight total product.
5. Organochlorines or polychlorinated biphenyls (PCBs) in excess of 1.0 ppm weight/weight total product.

H. Paint materials for each coating formula to be products of a single Manufacturer.

2.2 COLOURS

A. The Engineer will provide colour schedule after Contract Award. Submit proposed colour schedule to Engineer for approval.

B. Colour schedule will be based upon base colour on the selection of five (5) base colours.

C. Perform all colour tinting operations prior to delivery of paint to site unless approved in writing by Engineer.

D. Ensure each second coat in a three-coat system is tinted lighter colour that topcoat.

2.3 PAINT FINISHES

A. Formula 14 (Alkyd): For Primed Ferrous Metal to receive paint apply:

1. Spot Priming with Shop Primer.
2. One (1) Coat Zinc Chromate Primer CAN/CGSB-1.132.
3. Two (2) Coats Alkyd Gloss Enamel CAN/CGSB-1.59.
4. CPCA System: EXT-11-A, Premium. Gloss: Gloss.

B. Formula 15 (Epoxy): For Primed Ferrous Metal to receive epoxy paint apply:

1. Spot Priming with Shop Primer.
2. One (1) Coat Cold Cured Epoxy Primer CAN/CGSB-1.165 Type 1.

3. Two (2) Coats Cold Cured Gloss Epoxy CAN/CGSB-1.146.

4. CPCA System: EXT-11-D, Premium.

C. Formula 17 (Alkyd): For Galvanized and Zinc Coated Metal to receive paint apply:

1. One (1) Coat Cementitious Primer CAN/CGSB-1.198.

2. Two (2) Coats Alkyd Gloss Enamel CAN/CGSB-1.59.

3. CPCA System: EXT-12-A, Premium. Gloss: Gloss.

PART 3. EXECUTION

3.1 GENERAL

A. Perform all painting operations in accordance with CAN/CGSB-85.100.

B. Perform all painting operations in accordance with CPCA Painting Specifications Manual, except where specified otherwise.

C. Apply all paint materials in accordance with Paint Manufacturers written application instructions.

3.2 PREPARATION

A. Remove electrical cover plates, light fixtures, surface hardware on doors and all other surface mounted fittings, equipment and fastenings prior to undertaking any painting operations. Store for re-installation after painting is completed.

B. Cover or move portable equipment around building as necessary to carry out painting operations. Replace as painting operations progress.

C. As painting operations progress, place “WET PAINT” signs in areas of work to approval of Engineer.

3.3 PROTECTION

A. Protect exterior building surfaces not to be painted from paint splatters, markings and other damage. If damaged, clean and restore such surfaces as directed by Engineer.

B. Cover or mask windows and other ornamental hardware adjacent to areas being painted to prevent damage and to protect from paint drops and splatters. Use non-staining coverings.

C. Protect items that are permanently attached, such as fire labels on doors and frames.

D. Protect factory-finished products and equipment.

3.4 EXISTING CONDITIONS

A. Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Engineer all damage, defects, unsatisfactory or unfavourable conditions before proceeding with work.

B. Investigate moisture content of surfaces to be painted and report findings to Engineer. Do not proceed with work until conditions fall within acceptable range as recommended by Manufacturer.

C. Maximum moisture content as follows:

1. Masonry/Concrete: 12%.

2. Concrete Block/Brick: 12%.

3. Wood: 15%.

3.5 CLEANING

A. To prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.

1. Use trigger operated spray nozzles for water hoses.

2. Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such solvents to clean-up water-based paints.

B. Clean all surfaces to be painted as follows:

1. Remove all dust, dirt, and other surface debris by wiping with dry, clean cloths.

2. Wash surfaces with solution of T.S.P. bleach and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.

3. Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

4. Allow surfaces to drain completely and allow to dry thoroughly.

C. Prevent contamination of cleaned surfaces before prime coat is applied and between applications of remaining coats. Apply primer, paint or pre-treatment as soon as possible after cleaning and before deterioration occurs.

3.6 SURFACE PREPARATION

A. Sand existing surfaces.

3.7 SURFACE PREPARATION – METAL

A. Clean new metal surfaces to be painted in accordance with the following:

1. Solvent Cleaning: SSPC-SP-1.
2. Hand Tool Cleaning: SSPC-SP-2.
3. Power Tool Cleaning: SSPC-SP-3.
4. Commercial Blast Cleaning: SSPC-SP-6.
5. Brush-Off Blast Cleaning: SSPC-SP-7.

B. Clean metal surfaces to be repainted in accordance with following:

1. Scrape edges of old paint back to sound material where remaining paint is thick and sound, feather exposed edges.
2. Clean rusted and bare metal surfaces where existing paint system has failed.
3. Solvent Cleaning: SSPC-SP-1.
4. Hand Tool Cleaning: SSPC-SP-2.
5. Power Tool Cleaning: SSPC-SP-3.
6. Commercial Blast Cleaning: SSPC-SP-6.
7. Brush-Off Blast Cleaning: SSPC-SP-7.

C. Remove traces of blast products from surfaces, pockets and corners to be painted by brushing with clean brushes and blowing with clean, dry, compressed air.

D. Touch-up damaged or defective paint or rusted areas shop primer to CGSB 85.10-99 with primer as specified in applicable Section.

E. Prepare galvanized steel and zinc coated steel surfaces to CGSB 85.10-99.

F. Prepare new steel surfaces exposed normally to dry conditions to CGSB 85.10-99.

G. Prepare previously painted steel surfaces exposed normally to dry conditions to CGSB 85.10-99.

H. Prepare steel surfaces exposed to water or high humidity levels to CGSB-85.10-99.

I. Apply paint only after prepared surfaces have been accepted by Engineer.

3.8 MIXING PAINT

A. Do not use kerosene or any such organic solvents to thin water-based paints.

B. Mix ingredients in container before and during use and ensure breaking up of lumps, complete dispersion of settled pigment and uniform composition.

C. Thin paint for spraying according to Manufacturer's written instructions and provide copy to Engineer.

3.9 APPLICATION

A. Apply paint by brush, roller, air sprayer or airless sprayer as approved by the Engineer. Conform to Manufacturer's application instructions unless specified otherwise.

B. Brush Application:

1. Work paint into cracks, crevices and corners. Paint surfaces not accessible to brushes by daubers or sheepskins.

2. Brush out runs and sags.

3. Remove runs, sags and brush marks from finished work and repaint.

C. Spray Application:

1. Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied and equipped with suitable pressure regulators and gauges.

2. Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

3. Apply paint in a uniform layer, with overlapping at edges of spray pattern.

4. Brush out immediately all runs and sags.

5. Use brushes to work paint into cracks, crevices and places that are not adequately painted by spray.

D. Use dipping, sheepskins or daubers only when no other method is practical, in places of difficult access and only when specifically authorized by Engineer.

E. Apply each coat of paint as a continuous film of uniform thickness. Repaint spots or bare areas before next coat of paint is applied.

F. Allow surfaces to dry and properly cure after cleaning and between subsequent coats for a minimum time period as recommended by Manufacturer.

G. Sand and dust between each coat to remove visible defects.

H. Finish tops of projecting ledges, both above and below sight lines as specified for surrounding surfaces.

I. Finish top, bottom, edges and cut-outs of doors after fitting as specified for door surfaces.

3.10 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment unless specified otherwise. Colour to match adjacent surfaces, except as specified otherwise.

B. Touch-up scratches and marks on factory-painted finishes and equipment with paint as supplied by Manufacturer of equipment.

C. Paint exterior steel electrical light standards and diesel exhaust stack. Do not paint outdoor transformers and substation equipment.

D. Paint all fire protection piping Red.

E. Paint all-natural gas piping Yellow.

3.11 FIELD QUALITY CONTROL

A. Field inspection of painting operations to be carried out by independent inspection firm as designated by Engineer.

B. Advise Engineer when each applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.

C. Cooperate with inspection firm and provide access to all areas of the work.

3.12 RESTORATION

A. Clean and re-install all items that were removed before undertaking painting operations.

B. Remove protective coverings and warning signs as soon as practical after operations cease.

C. Remove paint splashings on exposed surfaces that were not painted. Remove smears and splatter immediately as operations progress, using compatible solvent.

D. Protect surfaces from paint droppings and dust to approval of Engineer. Avoid scuffing newly applied paint.

E. Restore areas used for storage, cleaning, mixing and handling of paint to clean condition, as approved by Engineer.

END OF SECTION

PART 1. GENERAL

1.1 INTENT

A. This Section covers the work required to identify all exposed piping and mechanical/electrical duct work with respect to labelling, flow arrows, and pipe and band colour coding.

B. Related Sections:

1. Section 09911 and 09912.

2. Divisions 11, 15 and 16.

1.2 QUALITY ASSURANCE

A. The work is subject to inspection by the Consultant at all times to ensure proper performance and compliance with the specification. Conform to all the Consultant's instructions.

B. Perform all work including storage of the product in strict accordance with the Manufacturer’s instructions and be responsible for obtaining same.

1.3 SUBMITTALS

A. Submit for the Consultant's review well in advance of any work of this Section or any painting work, the following:

1. Samples of the size, style and exact colour(s) of labels to be used, including any options available.

2. A complete legend of all items to be identified and colour coded indicating the pipe/duct service label name, pipe colour, band colour(s).

PART 2. PRODUCTS

2.1 GENERAL

A. Unless otherwise approved by the Consultant the products supplied for the labelling, arrows and banding is to be from a single Supplier.

2.2 IDENTIFICATION STICKERS/LABELS

A. Brady B-350 (tamper proof) thin vinyl film or approved equivalent able to withstand temperatures from -40 degrees C (-40 deg. F) to 121 degrees C (220 deg. F) apply at 10 degrees C (50 deg. F) or above.

B. Style 1, Lettering, 56 mm (2 1/4") high for piping larger than 75 mm (3") finished diameter (O.D.).

C. Style 4, Lettering, 28 mm (1 1/8") high for piping up to 65 mm (2 1/2") finished diameter (O.D.).

D. Style 2 and 4 arrows to match letter size, indicating flow direction immediately following the identification label in all cases.

2.3 BANDING

A. Paint on bands or provide stick-on bands to the colours required.

2.4 PAINTING

A. Painting as per Section 09911 and 09912.

PART 3. EXECUTION

3.1 IDENTIFICATION STICKERS/LABELS

A. Clean all surfaces thoroughly before application of the product.

B. Apply labels and arrows in a uniform manner truly parallel to the lines of pipe/duct, etc.

C. Apply labels and arrows on both sides of a large piece of equipment, on each side of a wall or floor, change of pipe direction, etc.

D. Arrows to point in the direction of flow, use double headed arrows for two-way flow.

E. Coat all labels/stickers with a coat of varathane type product.

F. Provide sufficient quantity of labels and arrows for a spacing of 5 m o.c. (16.5 ft.) for all pipes/ducts, etc., except 3 m o.c. (10 ft.) for gas lines.

G. See Drawing D5 for further details.

3.2 COLOUR CODING AND BANDING

A. Colour code and band all pipes/ducts, including insulated items.

B. Primary bands are to be 100 mm (4") wide with the secondary bands (if required) 25 mm (1") wide and installed over the centre of the primary band. Provide bands at 5 m o.c. (16.5 ft) for all pipes/ducts, except 3 m o.c. (10 ft) for gas lines.

C. See the Standard Drawing for details of the banding with relation to the labelling.

D. See the Colour Coding Schedule at the end of this Section for the colours of piping and banding.

E. Paint the pipes/ducts as required by the various codes with primary and secondary bands as, also, required by code.

F. Where codes do not apply, paint pipes/ducts the colour of the primary or secondary band code as indicated on the Colour Coding Schedule. Provide a primary or secondary band in the colour that is not used to paint the pipe/duct.

G. Where permitted by code and approved by the Consultant paint pipes/ducts, etc. the same colour as the final colour of the walls, ceilings, etc. and provide the primary and secondary banding colours as indicated on the Colour Coding Schedule.

3.3 COLOUR CODING SCHEDULE

A. The colours presented in this Schedule are general only and try to reflect the various code requirements. For pipe duties not listed refer to the code(s) of the authorities concerned and the Consultant.

3.4 GROUP 1 – SAFETY MATERIALS

	PIPING		LABELS/ARROWS	
Service/Legend	**Primary Band Colour**	**Pipe or Secondary Band Colour**	**Background Colour**	**Lettering/ Arrow Colour**
RAW WATER	GREEN	LT.GREY	GREEN	WHITE
TREATED WATER	GREEN	LT.BLUE	GREEN	WHITE
DOM.COLD WATER	GREEN	LT.BLUE	GREEN	WHITE
DOM.HOT WATER SUPPLY	GREEN	DK.BLUE	GREEN	WHITE
DOM.HOT WATER RECIRC.	GREEN	DK.BLUE	GREEN	WHITE
TEMPERED DOM.WATER	GREEN	DKBLUE	GREEN	WHITE
CHILLED WATER	GREEN	DK.BLUE	GREEN	WHITE
CONDENSER WATER	GREEN	DK.BLUE	GREEN	WHITE
STORM DRAIN	GREEN	BLACK	GREEN	WHITE
SANITARY DRAIN	GREEN	GREY	GREEN	WHITE
PLUMBING VENT	GREEN	BLACK	GREEN	WHITE
EFFLUENT WATER	GREEN	LT.YELLOW	GREEN	WHITE
RAW SLUDGE	GREEN	BROWN	GREEN	WHITE
RETURN SLUDGE	GREEN	BROWN	GREEN	WHITE
WASTE SLUDGE	GREEN	BROWN	GREEN	WHITE
SCUM	GREEN	BROWN	GREEN	WHITE
INSTRUMENT AIR	GREEN	GREEN	GREEN	WHITE
COMP.AIR	GREEN	GREEN	GREEN	WHITE
(LESS THAN 670 kPa) FILTRATE (SAN.)	GREEN	GREY	GREEN	WHITE

3.5 GROUP 2 – GAS/DANGEROUS MATERIALS

	PIPING		LABELS/ARROWS	
Service/Legend	**Primary Band Colour**	**Pipe or Secondary Band Colour**	**Background Colour**	**Lettering/ Arrow Colour**
HI TEMP.DOM.HOT WATER	YELLOW	BLACK	YELLOW	BLACK
L.P. STEAM	YELLOW	BLACK	YELLOW	BLACK
L.P. CONDENSATE	YELLOW	BLACK	YELLOW	BLACK
H.P. STEAM	YELLOW	BLACK	YELLOW	BLACK
H.P. CONDENSATE	YELLOW	BLACK	YELLOW	BLACK
STEAM VENT	YELLOW	BLACK	YELLOW	BLACK
BOILER BLOWOFF	YELLOW	BLACK	YELLOW	BLACK
BOILER FEED	YELLOW	BLACK	YELLOW	BLACK
ACID DRAIN	YELLOW	BLACK	YELLOW	BLACK
PROPANE GAS	YELLOW	ORANGE	YELLOW	BLACK
NATURAL GAS	YELLOW	ORANGE	YELLOW	BLACK
ALUM SOLUTION	YELLOW	GREEN	YELLOW	BLACK
LIQUID CHLORINE	YELLOW	--	YELLOW	BLACK
CHLORINE GAS	YELLOW	BLUE(M)	YELLOW	BLACK
CHLORINE SOLUTION	YELLOW	BLUE(L)	YELLOW	BLACK
POLYMER SOLUTION	YELLOW	GREEN	YELLOW	BLACK
HYDRAULIC OIL	YELLOW	ORANGE	YELLOW	BLACK
COMP.AIR (ABOVE 670kPa)	YELLOW	BLACK	YELLOW	BLACK
DIESEL EXHAUST	YELLOW	BLACK	YELLOW	BLACK
HOT WATER HTG.	YELLOW	BLACK	YELLOW	BLACK
GLYCOL SOLUTION HTG.	YELLOW	BLACK	YELLOW	BLACK
DIGESTER GAS	YELLOW	ORANGE	YELLOW	BLACK
FERRIC CHLORIDE	YELLOW	GREEN	YELLOW	BLACK
SODIUM OR CALCIUM	--	YELLOW	YELLOW	BLACK
HYPOCHLORITE SOL. LIME SOLUTION	YELLOW	ORANGE	YELLOW	BLACK
OZONE GAS	YELLOW	CARMEL	YELLOW	BLACK
HYDROFILOSILICIC ACID	YELLOW	PURPLE	YELLOW	PLACK
SODIUM SILICATE	YELLOW	GREEN	YELLOW	BLACK
SULPHURIC ACID	YELLOW	PURPLE	YELLOW	BLACK
ACTIVATED SILICA	YELLOW	GREEN	YELLOW	BLACK

Note: For pipelines in Group 1, complete pipe shall be painted in the colour designated. For hot water lines use 24 mm cloth tape banding for secondary colour.

B. For pipelines in Group 2, a 100 mm wide band of paint should be applied. Secondary colour should be a tape 25 mm wide wrapped around centre of primary colour band.

Identification Colour	G.G.S.B. Colour Standards
GREY	501-103
LIGHT GREY	501-108
DARK BLUE	502-103
BRIGHT BLUE	502-104
LIGHT BLUE	502-106
MID BLUE	502-208
LIGHT GREEN	503-323
DARK BROWN	504-102
BROWN	504-105
MID BROWN	504-107
YELLOW	505-101
LIGHT BROWN	505-206
ORANGE	508-102
RED	509-102
PURPLE	511-101
BLACK	512-101
WHITE	513-101

END OF SECTION

DIVISION 11

EQUIPMENT

INDEX

PART 1. GENERAL

1.1 INTENT OF SECTION

A. This Section covers the supply, delivery, supervision of installation and commissioning of process piping and valves and fittings.

B. The term “Process Piping” includes pipes and valves within structures.

C. The following piping systems are included in this Section:

1. Pumps Suction and Discharge Piping.
2. Other Process Piping.

D. Piping Systems NOT included under this Section include:

1. Domestic water systems.
2. Diesel generator cooling water system.
3. Diesel generator exhaust piping.
4. Diesel generator fuel pumping.
5. Other miscellaneous plumbing/drainage piping.
6. Heating.
7. Ventilation.
8. These systems are included in other Sections in the Specifications.

E. The Plans and Specifications are intended to set the acceptable minimum and shall not be construed to relieve this Contractor of the responsibility of:

1. Installing a complete, trouble-free system.
2. Good workmanship.

1.2 REFERENCES

A. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.

B. ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and other Special Alloys.

C. ANSI B16.20, Ring-Joint Gaskets and Grooves for Steel Pipe Flanges.

D. ANSI B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.

E. ANSI B18.2.1, Square and Hex Bolts and Screws.

F. ASTM A47M, Specification for Ferritic Malleable iron Castings.

G. ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.

H. ASTM A120, Specification for Pipe, Steel, Black, and Hot-Dipped Zinc Coated, (Galvanized) Welded and Seamless, for Ordinary uses.

I. ASTM A536, Specification for Ductile Iron Castings.

J. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.

K. CSA-B242, Groove and Shoulder type Mechanical Pipe Couplings.

L. CSA-W47.1, Certification of Companies for Fusion Welding of Steel Structures.

M. MSS-SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.

N. MSS-SP-71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.

O. MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

P. MSS-SP-85, Cast Iron Globe and Angle Valves, Flanged and Threaded Ends.

Q. ANSI 150, ASTM D-1784, all PVC valves with classification 12454A.

1.3 RELATED SECTIONS

A. Division 1 – General Requirements.

B. Division 3 – Concrete.

C. Section 05500 – Metal Fabrications.

D. Section 11430 – Submersible Pumps.

E. Division 13 – Instrumentation and Controls.

F. Division 15 – Mechanical.

1.4 SUBMITTALS

A. Submit the Shop Drawings and samples for review in accordance with Section 01330 – Submittals.

B. The Shop Drawing submission shall include, but not be limited to, the following:

1. General dimensioned layout and materials list for all valves.

2. Valve list showing valve torque requirements corresponding motorized operator torque capability.

3. Summary list showing valve tag numbers, size type of operator, valve class, location, motorized operator number, pipe system including pipe schedule, materials.

4. Submit Manufacture's catalogue literature indicating the valves, bends, couplings, cocks, fittings, pipes, gaskets and other required materials.

5. Descriptive material in sufficient detail to show the general construction pertinent to the proper review.

6. The Supplier shall indicate a list of spare parts, which would be recommended to purchase and individual prices for each item.

7. All ancillary equipment to be provided by the Supplier shall be listed.

8. Special accessories or tools for the adjustment or removal of parts required for any piece of equipment shall be listed and furnished as part of the supply.

9. Grooved joint couplings and fittings shall be as on Drawings and product submittals and shall be specifically identified with the applicable style and series designation.

1.5 MAINTENANCE DATA

A. Refer to Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

1.6 MEASUREMENT AND PAYMENT

A. Work outlined in this Section is included in the Lump Sum Tender Price.

PART 2. PRODUCTS

2.1 PIPE

A. General – Supply all pipes, valves and fittings of the materials, size, classes and types as shown on the Contract Drawings and as specified herein.

B. All pressurized process piping systems shall be designed for:

1. Working pressure of 690 kPa (100 psi).

2. Field test at 1034 kPa (150 psi).

3. Transient pressure of 100 per cent of working pressure, i.e., total pressure = 1380 kPa (200 psi).

2.2 STAINLESS STEEL PIPING AND FITTINGS

A. All piping systems specified here shall be fabricated from stainless steel. Pipe wall thicknesses, schedules or USS gauges are shown on the Drawings and/or noted herein.

1. New raw sewage piping at Pumping Station.

2. Sampling pipes.

3. Other process piping as noted on the Contract Drawings.

4. Sensors/transmitters and gauges.

B. Stainless steel piping systems shall be fabricated using the table below as a guideline.

TABLE 2.1: SUITABILITY OF STAINLESS STEEL IN WATER

Chloride Levels	Stainless Grades
<200 ppm	304L, 316L
200 – 1,000 ppm	316L, Duplex Alloy 2205
1,000 – 3,500 ppm	Duplex Alloy 2205 6% Mo Superaustentic, Superduplex
>3,500 ppm	6% Mo Superaustentic, Superduplex
15,000 – 25,000 ppm (Sea Water)	6% Mo Superaustentic, Superduplex

C. From Nickel Institute fabricating stainless steel water industry.

D. Material thickness shall be based on the following Table 2.2.

TABLE 2.2: 1,035 kPa AND LESS THAN 150°C			
Material Size	**Thickness**	**Pipe**	**Fittings**
75 mm to 600 mm ID	Schedule 10S	A778	A774
75 mm ID	4.8 mm	A778	A774
900 mm to 1,200 mm ID	5.08 mm	A778	A774
1,500 mm to 1,650 mm ID	6.35 mm	A778	A774
1,800 mm to 2,100 mm ID	9.53	A778	A774

E. The stainless steel piping system, including tees, elbows, lateral fittings, flanges, specials and couplings, etc., shall be designed and reinforced for 1,035 kPa (150 psi) cold water working pressure unless otherwise indicated.

F. The stainless steel piping and fittings shall be manufactured from Type Proper Grade L or 316L Stainless Steel produced from parent metal conforming to ASTM A240 and AWWA Manual M11 and reinforced.

G. The Manufacturer shall provide the Engineer with a chemical analysis confirming material grade with each batch of stainless steel piping.

H. NPS 50 mm and smaller piping systems may be installed with the Vic-Press grade to match the stainless steel piping system. The pipe shall be wall thickness stainless steel conforming to ASTM A403/A774. Fittings shall be precision, cold drawn, stainless steel with elastomer O-ring seals (grade to suit intended service). The Vic Press properly graded stainless steel system shall be rated to 2,068 kPa (300 psi).

I. The wall thickness shall be designed to withstand full vacuum, working pressure and surge pressure. The pipe shall be carefully die formed or rolled true to dimension and round within a tolerance ±1.5 mm. Ends of the pipe and fittings shall be perpendicular to the longitudinal axis.

J. Prior to welding, submit copies of the Procedure Qualification Report for each type and size of weld required.

K. All stainless steel fabrication shall be conducted in a specific area that is separate from fabrication of all other materials such as carbon manganese steel to prevent cross contamination.

L. Carry out welding of stainless steel as specified under Subsection 3.4. Shop assemble pipe and fittings and weld in an accredited welding shop by certified welders for specified type of medium. Field welds are allowed only where pipe assembles are too large or awkward to install. Obtain approval of the Engineer for all field welds.
All welds, including fittings and spool piece assembles, will be full penetration welded butt joints, except for flanges and collar rings.

M. For pipe wall thickness up to 4.76 mm (3/16") and the root pass on thicker materials use inert-gas tungsten arc (TIG) welding process, with 100% argon purge backing gas. The weld penetration surface shall be gold/silver in appearance when completed. A blue appearance is not acceptable and must be redone. Subsequent passes shall be by the gas metal arc (MIG) process.

N. Visual of all welds to ASME B31.3 Table 341.3.2 normal and Category M fluid service shall be acceptable.

O. The pipes shall be pickled by immersion in acid bath or pickle paste when immersion is not possible for removal of weld discolouration and iron pickup. After pickling, the pipe and fittings shall be thoroughly washed with fresh clean water and air dried. The exterior finish of the pipe work shall be in accordance with the Manufacturer's recommendations unless otherwise noted herein.

P. Joints shall be welded or grooved end unless otherwise noted on the Drawings.

Q. Pipe couplings shall be YNC, Straub, Victaulic Depend-O-Loc or Victaulic grooved style and shall be provided as noted on the Drawings or as deemed necessary for expansion and/or maintenance purposes.

R. Schedule 10S pipe ends used for Victaulic grooved piping systems shall be grooved using Victaulic "RX" roll sets specifically designed for grooving stainless steel pipe.

S. After the piping system has been installed and tested, the Contractor shall pickle wash the stainless steel piping system to remove weld discolouration and iron pickup. After pickling, the pipe and fittings shall be thoroughly washed with fresh clean water and air dried before inspection by the Engineer. If deemed necessary by the Engineer, the Contractor may be required to repeat the entire pickle wash procedure.

TABLE 2.3: SCHEDULE OF STAINLESS STEEL PIPE WORK AND FITTINGS

Item	Size Range (mm)	Gauge USS	Description
Flanges	38 to 300 350 or Greater	Schedule 10	Rolled Van Stones or Stub End Type or Victaulic Ridgelock.
Backing Flanges	38 to 1500 200 to 250 300 to 350 400 to 450 500 to 550 600 750 900		Galvanized Carbon Steel Drilled to ANSI B16.1 Class 125. Backing flanges in chambers and submerge conditions shall be constructed to type proper grade stainless steel.
Gaskets	All Sizes		3 mm full face neoprene suitable for potable water.
Couplings	50 to 300		Couplings shall be constructed of galvanized steel. Couplings in cambers and submerged conditions shall be constructed of type proper grade stainless steel.

TABLE 2.3: SCHEDULE OF STAINLESS STEEL PIPE WORK AND FITTINGS			
Item	**Size Range (mm)**	**Gauge USS**	**Description**
	50 to 300		Roll-grooved style couplings for design pressures up to 2,068.4 kPa (300 psi) shall be Victaulic Style 89 or 489 (stainless steel) for rigid. Couplings shall be galvanized or type proper grade stainless steel.
	350 to 600		Roll-grooved style couplings for design pressures up to 1,378.9 kPa (200 psi) shall be Victaulic Style W89 for rigid. Couplings shall be galvanized.
	50 to 450		Roll-grooved style couplings for design pressures up to 2,068.4 kPa (300 psi) shall be Victaulic Style 77 (ductile iron) or 77S (stainless steel) for flexible joints. Victaulic roll-grooved style couplings shall be galvanized or type proper grade stainless steel.
	All Sizes		Grooved style couplings for design pressures up to 1,206.5 kPa (175 psi) shall be Victaulic Style 31 and 44. Closure style shall be Supplier complete with stainless steel type DVIC rings. Victaulic grooved style couplings shall be galvanized. Compression couplings shall be type proper grade stainless steel as supplied by Straub or YNC.
			Split sleeve couplings for design pressures up to 2,068.4 kPa (300 psi) shall be fusion bonded epoxy coated or stainless steel Victaulic Depend-O-Lock FXF or FXE or EXE.
Studs, Nuts, Bolts and Washers	All Sizes		Studs, nuts, bolts and washers shall be best quality type proper grade stainless steel heavy hex bolts complete with hex nuts. Use anti-seize lubricant on stainless steel bolts. Note, if 316 is used for bolts, the nuts shall be 304 or vice versus.
Flanges	40 to 350 400 or Greater	Equal wall to pipe wall of same size Equal wall to pipe wall of same size	Pressed neck type – butt welded. Rolled angle type.
Elbows	40 to 900	Equal wall to pipe wall of same size	Smooth flow or fabricated mitred type – butt welded.
Tees, Crosses, Reducers	40 to 900	Equal wall to pipe wall of same size	Fabricated type – butt welded or Victaulic.

2.3 DUCTILE IRON (DI)

A. This work comprises the supply and installation of the Ductile Iron CL53 piping, and fittings as shown on the Drawings. Gaskets shall be full ring 3 mm (1/8") red rubber. All process piping and fittings shall be Ductile Iron CL53.

B. Pipework shall be of approved Manufacture and shall conform to the following Specifications:

1. DI pipe ANSI A21.50 latest revision.

2. DI Flanged fittings and flanges, ANSI A21.11 and A21.10.

3. Pipe wall thickness for grooved and threaded end pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size	Minimum Class	
	Threaded Ends (1)	Grooved Ends (2)
100 – 400	53	53
450	53	54
500	53	55
600	53	56
750	53	56

4. Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

5. Complies with ANSI/AWWA C606 for grooved and shouldered joint ductile iron pipe.

C. Pipework shall be coated externally with an epoxy coating in accordance with Std. Spec AWWA C-116, and internally with a cement mortar lining in accordance with Std. Spec. ANSI/AWWA C104/A21.4-08. Interior pipes shall not be larger than 5.4 m (18') in length and shall be shorter where directed by the Engineer.

2.4 COPPER TUBING AND FITTINGS

A. Supply and install copper tubing and fittings for the following applications as shown on the Drawings and specified herein.

B. Tubing shall be high quality soft annealed copper tubing to ASTM B-75 or equivalent. Also, soft annealed (Temper O) copper water rube Type K or Type L to ASTM B-88.

2.5 FASTENERS

A. Studs, nuts and washers shall be galvanized.

2.6 SWING FLEX CHECK VALVES

A. Supply and install Swing Flex Check Valves size and location as shown on the Contract Drawings and/or specified herein.

B. The check valve shall be of the full body flanged type, with only one moving part, the flexible disc.

C. Valve shall be provided with flanges in accordance with ANSI B16.1, Class 125.

D. The top access port shall be full size, allowing removal of the disk without removing the valve from the line.

E. A threaded port with plug shall be provided on the bottom of the valve complete with a backflow actuator.

F. A thread post with plug shall be provided in the cover to allow for field installation of a position indicator at a later date without the need of special tools or removing the valve from the line.

G. The valve body shall have 100% pipe flow area, with no restrictions at any point, through the valve.

H. The disc shall be of on piece construction precision molded Buna-N ASTM D2000-BG with an integral O-Ring type sealing surface and contain steel and nylon reinforcements in both the pivot and central disc area.

I. The flex portion of the disc shall be warranted for 25 years.

J. Non-slam closing characteristics shall be provided through a short 35 degree disc stroke and a memory disc return action.

K. The valve body shall be constructed of ASTM A126 Class B cast iron.

L. The interior and exterior of the valve shall be coated with a fusion bonded epoxy at the Manufacturer's facility.

M. Acceptable Suppliers:

1. Pratt Model 851 with back flow actuator.

2. Val-Matic Series 500 complete with back flow actuator.

3. APCO Series 100 complete with backflow actuator.

4. Newman – Hattersley complete with backflow actuator.

2.7 PLUG VALVES

A. Supply and install plug valves as shown on the Contract Drawings and/or as specified herein.

B. Provide plug valves with the following features:

1. The valve body and cover shall be constructed of ASTM A126 Class B cast iron. The works "SEAT END" shall be cast on the exterior of the body seat end.

2. The plug shall be of one-piece construction and made of ASTM A126 Class B cast iron with a resilient facing per ASTM D2000-BG and AUSI/AWWA C504 requirements.

3. ANSI B16.1 Class 125 flanged ends for valves 75 mm and greater.

4. Screwed ends for valves less than 75 mm.

5. Drip tight shut-off for full pressure rating in either direction with welded-in nickel seats.

6. Lubrication of the stem sealing area and the lower trunion.

7. All valves 100 mm and larger shall be supplied with a gear actuator.

8. Valve actuator shall be suitable for continuous submerged conditions.

9. The interior and exterior of the valve shall be fusion bonded epoxy coated at the Manufacturer’s facility.

C. Acceptable Suppliers:

1. Pratt 601

2. Valmatic.

3. Newman Hattersley.

4. Dezurik.

5. Golden Anderson.

2.8 SEWAGE AIR RELEASE VALVES

A. Supply and install air release size and location as shown on the Contract Drawings and/or specified herein.

B. Air Release Valves shall be automatic float operated valves designed to release accumulated air from a piping system while the system is in operation and under pressure.

C. The valve body shall have full size NPT inlets and outlets.

D. The valve body and cover shall be constructed of cast iron.

E. The orifice, float and linkage mechanism shall be constructed of Type 304 Stainless Steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be BUNA-N.

F. Backwash accessories shall be furnished and shall consist of an inlet shut-off valve, a blow-off valve, a clean water inlet valve, rubber supply hose and quick disconnect coupling. Accessory valves shall be quarter-turn, full port bronze bell valves.

G. The interior and exterior of the valve shall be fusion bonded epoxy coated at the Manufacturer's facility.

H. Acceptable Suppliers:

1. Pratt WAR
2. Val-Matic Series 48.
3. APCO Series 400.

I. Air Release Valves shall be supplied with a Stainless Steel Ball Valve for isolation, size to match inlet orifice. Ball valves shall be WATTS BVF Full Port or approved equal.

2.9 SEWAGE AIR AND VACUUM COMBINATION VALVES

A. Supply and install air release size and location as shown on the Contract Drawings and/or specified herein.

B. The sewage air and vacuum valves shall allow unrestricted venting or re-entry of air to prevent vacuum. The sewage air and vacuum valves shall incorporate two stainless steel floats directly connected by a stainless steel float guide so as to maintain an air gap between the top shut off float and the bottom float to prevent solids from fouling or clogging the top float. The valve shall have an internal baffle fitted with a guide bushing and act to protect the shutoff float from direct air flow.

C. All internals shall be easily removable through the top cover without removing the main valve from the lines.

D. The valve body shall have full size NPT inlets and outlets.

E. The valve body and cover shall be constructed of cast iron.

F. The orifice, float and linkage mechanism shall be constructed of Type 304 Stainless Steel. Non-metallic floats or linkage mechanisms are not acceptable. The orifice button shall be BUNA-N.

G. Backwash accessories shall be furnished and shall consist of an inlet shut-off valve, a blow-off valve, a clean water inlet valve, rubber supply hose and quick disconnect coupling. Accessory valves shall be quarter-turn, full port bronze bell valves.

H. The interior and exterior of the valve shall be fusion bonded epoxy coated at the Manufacturer's facility.

I. Acceptable Suppliers:

1. Pratt WWCV
2. Val-Matic Series 801A – 804.
3. APCO Series 400.

J. Air Vacuum Valves shall be supplied with a Stainless Steel Ball Valve for isolation, size to match inlet orifice. Ball valves shall be WATTS BVF Full Port or approved equal.

2.10 PRESSURE GAUGES (WASTEWATER SYSTEMS)

A. Supply and install pressure gauges as shown on the Contract Drawings and specified herein.

B. Pressure gauges shall be 114 mm dial size with fibreglass reinforced polypropylene case, threaded ring, solid front, blow out back, molded acrylic window.

C. Movement shall be stainless steel.

D. Bourdon tube shall be bronze.

E. Dial face shall be white with black figures, pointer shall be micrometer adjustable type.

F. Dual scale and operating range shall be -140 kPa to 140 kPa (-20 psi to +20p si) for pressure gauges installed on the pump suction piping, and 0.0 kPa to 1105 kPa (0.0 psi to 160 psi) for all other pressure gauges.

G. Pressure gauges shall be liquid filled.

H. All other pressure gauges shall be supplied with a diaphragm. Surfaces exposed to media to be stainless steel (lower housing). Seal shall be of the continuous duty safety type complete with locking device.

I. Pressure gauge shall be supplied with a stainless steel nipple and quick disconnect connection fitting.

J. Acceptable Suppliers:

1. Trerice Type 450 LFB.

2. Ashcroft Durogauges, Type 1279 ASL.

3. Ametek US Gauge.

2.11 SEWAGE PRESSURE RELIEF VALVE

A. The pressure relief valve shall be a smooth 90° elbow configuration, ductile iron body with 12 mils of coating of heat fused epoxy. The seat and stem shall be 316 Stainless Steel. The stem shall be guided by a long, bronze guide bushing and designed to handle large solids.

B. The valve body shall be supplied with ANSI Class 150 flanges.

C. Full system pressure shall be applied to the opening piston by means of a separation chamber and flexible diaphragm separation, transmitting the system pressure to the clean, non-toxic liquid and in turn the piston.

D. It shall be possible to test cycle or flush the valve by applying external pressure to the separation chamber, without disassembly or use of special tools.

E. The relief setting shall be adjusted at the factory, prior to shipping, by use of the spring compression nuts.

F. Closing speed shall be adjusted using a flow control in the clean liquid.

G. The interior and exterior of the valve shall be fusion bonded epoxy coated at the Manufacturer's facility.

H. Acceptable Suppliers:

1. Singer Model 106DL.

2. Golden Anderson Figure 626.

2.12 GATE VALVES

A. Supply and install gate valves at the sizes and locations shown in the Contract Drawings and specified herein.

B. Resilient Wedge Gate Valves:

1. Unless indicated otherwise on the Drawings, gate valves where shown shall be of the resilient wedge type conforming to the latest revision of AWWA Standard C-509. The valves shall be non-rising stem type. Unless shown otherwise on the Drawings the valves shall be handwheel operated. Provide chain wheel operation, motorized actuators, extension stems, floor standing operators, operators complete with crank handles or actuators as shown on the Drawing.

2. The valves shall have a body from cast iron conforming to ASTM A126 Class B and shall be flanged to ANSI B16.5 Class 150. The wedge shall be of cast iron to ASTM 126 Class B and shall be fully encapsulated with urethane rubber. Stem shall be low zinc cast bronze with integral collars in full compliance with AWWA Standards. NRS stem stuffing box shall be 'O' ring seal type with two (2) 'O' rings which shall be replaceable with the valve fully open and under pressure.

3. The body and bonnets shall be coated internally and externally with a suitable corrosion resistant finish formulated from materials suitable for use on sewage.

C. Bronze Wedge Gate Valves:

1. The Contractor shall supply and install bronze wedge gate valves for the following applications:

   a. Steel piping systems where indicated.

   b. General isolating service on pipelines 40 mm and smaller.

2. Bronze wedge gate valves 40 mm diameter and smaller except as otherwise noted, shall have NPT threaded ends in accordance with ANSI B2.1. Bronze gate valves 40 mm and larger shall have end connections flanged to ANSI B16.1 Class 150. Valves shall be Class 150 and shall have a non-rising stem, solid wedge disc with stuffing boxes precision machined and filled with high grade, non-asbestos packing to ensure a tight step seal.

3. Bronze wedge gate valves with screwed end connections shall have unions fitted either side of them to facilitate easy removal from the pipeline.

4. The bronze wedge gate valves shall be Valves shall be Jenkins Fig 2310, Crane #437 or reviewed equivalent.

5. Acceptable Suppliers:

   a. Mueller, Clow AVK or reviewed equivalent Stafsjo Model MVE (for Valves 300 mm or small).

   b. Seguro as supplied by Neo Valves or reviewed equivalent (for Valves 350 mm and larger).

PART 3. EXECUTION

3.1 INSTALLATION AND INSPECTION

A. The piping, valves, fittings and accessories shall be installed as indicated on the Contract Drawings, in accordance with the Manufacturer's recommendations and as approved by the Engineer.

B. Refer to Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

C. Provide the services of a Factory Trained Representative(s) to inspect, operate, test, adjust, and troubleshoot the installation.

D. The Factory Trained Representative(s), mentioned above, will certify that the equipment is ready for operation before use. In addition, the Factory Trained Representative(s) shall instruct the City's Operation personnel in the proper operation and maintenance of the equipment supplied.

E. Provide for additional supervision of installation by Equipment Supplier as required.

F. Arrange with the Engineer a mutually agreeable date when the Representative should be on site.

G. Submit a report, signed by the Manufacturer's Representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment conforms to all Specifications.

H. Inspection to include checking for:

1. Cracks and other damaged or defective parts. The equipment must be undamaged, without cracks and free of defective parts.

2. Completeness of installation as specified and as recommended by the Manufacturer.

3. Correctness of setting, alignment and relative arrangement of various parts of the system.

3.2 HANDLING

A. Provide proper equipment and tools for safe and convenient handling and installation of pipes, fittings, valves and other accessories.

B. Exercise particular care to prevent abrasion of pipe coating.

3.3 SIZING

A. Supply and install pipes, valves and other fittings according to the sizes indicated on Drawings. Where sizes are not clearly indicated, obtain sizes from the Engineer before proceeding with the work.

3.4 MECHAMICAL TESTING AND CERTIFICATION

A. Afterstart-up and prior to final acceptance, the Contractor shall conduct Engineer-witnessed performance tests on the equipment.

B. The Field Service Representative will cause the piping, valves and fittings to perform all mechanical functions that they have been designed to perform. Tests will be scheduled with the Engineer at least two (2) weeks prior to the planned test date.

C. The Field Service Representative shall submit to the Engineer a written report stating that the equipment has been checked and is suitable for operation.

3.5 LEAKAGE TESTING

A. All valves larger than 900 mm in diameter are to be shop leak tested to the AWWA pressure rating for 10 minutes on each side of the disc, with no leakage allowed, prior to delivery to site.

3.6 SUPERVISION OF INSTALLATION AND COMMISSIONING

A. Test and commission the equipment in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. At the completion of satisfactory installation, each valve, gates, and/or section will be tested by the General Contractor under the supervision of the Supplier and the Engineer. All controls and alarms shall be checked and tested to ensure proper control and equipment protection.

C. Equipment installation shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's Representative.

D. Modify or replace equipment or materials failing required tests.

E. Perform additional testing required due to changes of materials and/or failure of materials or construction to meet Specifications at no extra cost to the City.

3.7 STORAGE

A. Prior to the installation the piping, valves, fittings and accessories shall be protected and stored indoors in a dry area, in accordance with the Manufacturer's recommendations.

3.8 MAINTENANCE

A. Provide maintenance on Supplier's equipment as required by the Supplier from the date of delivery to the initial start-up.

END OF SECTION

PART 1. GENERAL

1.1 General

A. All conditions of the contract apply to the work of this Section.

1.2 SCOPE OF WORK

A. This Section covers the supply, installation and commissioning of miscellaneous pumps, drives and accessories as specified herein and shown on the Contract Drawings.
The work includes but is not limited to the following:

1. Sump Pump for Valve Chamber.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 11000 – Equipment General Clauses and Installation.

B. Section 11100 – Process Piping and Valves.

C. Section 16010 – Electrical General Requirements.

1.4 SHOP DRAWINGS

A. Submit all Shop Drawings, Manuals, Parts Lists, etc., in accordance with Division 1, Section 01330 – Submittals.

1.5 QUALITY ASSURANCE

A. The Manufacturer shall have at least 20 years' experience in the production of effluent/liquid samplers and shall provide references.

B. The Manufacturer shall have a CSA certified shop in which they manufacture the samplers and shall have a CSA sticker on the final product.

PART 2. PRODUCTS

2.1 SUMP PUMP

A. Furnish and install one (1) submersible non-clog sewage pump complete with start/stop float switches as well as manual start/stop switches on starter panel as shown on the Drawings. Pump shall be capable of delivering a minimum 2.5 L/s at 12 m TDH with a shut off head of 7 m TDH (minimum) and 60% minimum efficiency at 2.5 L/s at 12 TDH (minimum operating point). The pump motor speed shall be 1750 RPM, 0.3 kW (maximum), single phase, 60 Hertz, 120 Volts. The pump(s) shall be manufactured in North America by a company regularly engaged in the manufacture and assembly of similar units for a minimum of five (5) years. The pump(s) shall be Supplied by Liberty Pumps (XLE50-Series); Myers SX50 or reviewed equivalent.

B. Pump Design: Each pump shall be capable of handling raw, unscreened domestic sewage consisting of water, fibrous materials, and 20 mm diameter spherical solids. The pump(s) shall be capable of handling liquids with temperatures to 40EC continuous, 70EC intermittent and shall be capable of running dry for extended periods. Pump shall be capable of being operated "dry" for extended periods without damage to motor and/or seals. The pump/motor unit shall also be approved by CSA for service in Class I, Division 2, Group D Hazardous locations.

C. Pump Construction: The volute, seal plates, impeller and motor housing shall be constructed of high quality cast iron. The pump(s) shall be painted with an epoxy coating of 2.0 mil minimum thickness. All exposed hardware shall be 300 series stainless steel. The pump construction shall contain no points of critical clearance nor require periodic adjustment or replacement to maintain operating efficiency. Discharge connection shall be a standard 50 mm NPT in the vertical position. All gaskets shall be of the compression square ring type eliminating critical slip fits and the possibility of damage during service associated with sliding O-ring sealing arrangements.

D. The impeller shall be of the non-clog design with pump out vanes on the back side. The impeller shall be dynamically balanced to ISO G6.3 Specifications.

E. The unit shall utilize a single mechanical shaft seal which will operate in an oil atmosphere. The materials of construction shall be carbon for the rotating face and ceramic for the stationary face, lapped and polished to a tolerance of one light band, 300 series stainless steel hardware, and all elastomer parts to be of Buna-N. The seal shall be commercially available and not a proprietary design of the manufacture.

F. The pump shall be designed to be non-overloading throughout the entire pump curve. The rotor and stator assembly shall be of the standard frame design and secured to the pump seal plate by four threaded fasteners allowing for easy serviceability. Motor designs incorporating shrink or press fi t assembly between the stator and motor housing shall not be acceptable. The motor shall be constructed with the windings operating in a sealed environment containing clean dielectric oil, making it capable of operating in a totally, partially or non-submerged condition for extended periods of time without damage due to the heat being generated. Air-filled motors shall not be acceptable. The motor windings shall be of Class B insulation. The motor shall meet the Standard NEMA Design L for single phase and NEMA Design B for three (3) phases. The motor shaft shall be of 416 Stainless Steel. The lower bearing shall be of the single ball type to accept radial and thrust loads, and the upper bearing of the sleeve or ball design, for radial loads. Bearings shall operate in an oil bath atmosphere for superior life. Permanently lubricated bearings are not acceptable. Thermal sensor shall be used on three phase units to monitor stator temperatures. The stator shall be equipped with a thermal switch embedded in the end coil of the stator winding. This shall be used in conjunction with external motor overload protection and wired to the control panel. Single phase shall have an overload switch on the motor windings and do not require any external protection.

G. The pump shall be equipped with 30 m of type SOW power cable and connected to the motor via quick disconnect pin terminals. Threaded cord grip type cord entries are not acceptable. Pin receptacles shall be crimped and molded to the power cord in a PVC plug. The plug shall be secured with a stainless steel compression plate to prevent water from entering the housing and to provide strain relief at the point of cable entry. A stainless steel clamp shall compress the PVC molding against the cable jacket to prevent water from entering the jacket. A polybutylene terephthalate terminal block with brass pin inserts shall connect the power cord leads with the motor leads. The ground pin shall be longer than the other pins such that the ground connection is the first connection made and the last connection broken when the plug is inserted and removed, respectively. A Buna-N O-ring shall provide isolation sealing between the terminal block and the motor housing when the cord plug is removed.

H. Pump Test: The Pump Manufacturer shall perform the following inspections and tests in accordance with Hydraulic Institute Type B Standards before shipment from the factory:

1. A check of the motor voltage and frequency shall be made as shown on the name plate.

2. A motor and cable insulation test for moisture content or insulation defects shall be made per UL criteria.

3. The pump shall be completely submerged and run to determine that the unit meets three pre-determined hydraulic performance points.

4. A written report shall be available showing the aforementioned tests have been performed in accordance with the Specifications.

2.2 ELECTRICAL COMPONENTS

A. General:

1. Provide all necessary electrical components and wiring for a complete, functional system. Electrical components shall be provided in accordance with the requirements of Division 16 – Electrical and Division 13 – Instrumentation & Controls.

2.3 CONTROLS

A. Control Panels: Provide one control panel:

1. Control panel to be located above grade level, as shown on the Contract Drawings.

B. Operator Controls and Indicators: As a minimum, provide the following functions on the face of the control panel:

1. Hand Switches:

   a. POWER ON/OFF (selector switch).

   b. START/STOP (pushbuttons).

2. Status Indicating Lights:

   a. Power ON.

   b. Pump ON/OFF.

3. Functional Requirements:

   a. With the POWER ON/OFF handswitch in ON position, the pump is controlled with the local START/STOP pushbutton.

   b. Provide any necessary fail-safe interlocks required to protect the equipment.

   c. Provide a pad lockable cover over face of control panel for protection.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install equipment and accessories in accordance with Manufacturer's recommendations and to the satisfaction of the Engineer including all necessary materials not specifically noted herein or shown on the Contract Drawings or provided by the Equipment Supplier in order to make the mechanical and electrical connections as required for the specified operation of the equipment.

B. Employ skilled mechanics to supervise the installation.

3.2 COMMISSIONING AND CERTIFICATION

A. Arrange and pay for a Qualified Technical Representative of the Equipment Supplier to commission the installation.

B. Arrange for the Engineer and Owner's Representative(s) to be present at the time of commissioning.

C. Demonstrate that all the equipment is installed properly and is performing satisfactorily.

D. Obtain a certificate from the Supplier stating that their Qualified Representative has found the installation to be to their satisfaction. Submit the certificate to the Engineer.

END OF SECTION

PART 1. GENERAL

1.1 INTENT OF SECTION

A. This Section covers the supply, delivery, supervision of installation and commissioning of two (2) submersible wastewater pumps (wet pit installation).

B. The Contractor is responsible for overall coordination of the equipment package to ensure compatibility of all pump units with their respective motors and accessories, and with the proposed works.

1.2 RELATED SECTIONS

A. Division 1 – General Requirements.

B. Division 3 – Concrete.

C. Division 5 – Metals.

D. Division 13 – Instrumentation & Controls.

E. Division 16 – Electrical.

1.3 OPERATING CONDITIONS

A. The following site operating, and water quality conditions must be assumed for all design calculations:

1. 40/C maximum/5/C minimum ambient air temperature.
2. 25/C maximum/10/C minimum water temperature.
3. 95% maximum relative humidity (non-condensing).
4. 7.5 – 8.5 water pH.
5. Elevation 260± meters above sea level.
6. Fully enclosed facility.

B. Refer to the Contract Drawings for further details.

1.4 SUBMITTALS

A. Submit the Shop Drawings for review in accordance with Section 01330 – Submittals.

B. The Shop Drawing submission shall include, but not be limited to, the following:

1. Dimensional Drawings showing pump layout and sections together with Motor and Anchor Bolt Base Plans.

2. Refer to Division 16 – Electrical for electrical requirements.

3. For each major component include the name of the Manufacturer, type and model of equipment.

4. Pump performance and efficiency curves, showing capacity versus head, NPSH required, pump efficiency, and BEP for range of pump speed.

5. Dimensional Drawings and recommended installation.

6. Motor Data Shop Drawing submission.

7. Description of the materials of construction of major components. Provide sufficient detail to show the general construction pertinent to the proper review of the equipment.

8. A precise list of all electrical requirements for the equipment including all controls, monitoring equipment and instruments shall be given including all power characteristics and materials of construction. A wiring schematic and single line diagram of the control panel(s) must be included.

9. The Supplier shall indicate a list of spare parts which he/she would recommend be purchased and individual prices for each item.

10. All ancillary equipment to be provided by the Contractor shall be listed.

11. Special accessories or tools for the adjustment or removal of parts required for any piece of equipment shall be listed and furnished as part of the supply.

12. Submit Table 2 – Date Form along with the Tender Bid.

1.5 MAINTENANCE DATA

A. Refer to Section 01330 – Submittals.

B. Work outlined in this Section is included in the Lump Sum Tender Price.

1.6 MEASUREMENT AND PAYMENT

A. Work outlined in this Section is included in the Lump Sum Tender Price.

PART 2. PRODUCTS

2.1 GENERAL

A. Provide two (2) submersible, non-clog wastewater pumps and associated equipment that conforms to the requirements specified herein and suitable for the installation at the locations shown on the Contract Drawings.

Pump Type	Qty.	Duty Point 1 (max flow) Single Pump Operation	Location
Submersible	2	67± L/s @ 27.7 m TDH	Wet Well

B. Each pump shall be equipped with a minimum 33 kW (44 hp), submersible electric motor connected for operation to 600 Volts, 3 phase, 60 hertz, 1800 RPM, with 30 metres of submersible SOW cable. The cable shall be sized according to CSA Standards and carry a CSA Approval. Also, 30 metres of submersible SOW cable will be used for pump monitoring device signals.

C. Pump(s) and associated equipment that conform to the requirements specified herein and suitable for installation at the location shown on the Contract Drawings, all with inverter duty rated motors, suitable for VFDs with the following features.

D. Each pump shall be supplied with a submerged discharge elbow base (duckfoot bend), cast iron, 150 mm (6 inch) x 150 mm (6 inch) for pump automatic installation and removal along with pump guide bars.

E. Each pump shall be fitted with 10 metres of galvanized steel lifting chain. The safe working load of the lifting chain shall be at least 40% greater than the pump weight.

F. Each pump shall be designed for operation with flooded suction and NPSH available at the wet well low water level 0.2 m above pump volute centerline, when only one pump running at the highest flow rate. The submissions shall include suction specific speed and suction energy level for each pump. The NPSH margin ratio is the NPSH available divided by NPSHR. The minimum margin ratio requirement at pump duty points is 1.2. Margin between NPSH available and NPSHR shall not be less than 1.5 m within the entire pump operating range.

2.2 PUMP DESIGN

A. The pumps power and pilot cable supports shall be provided and consist of a wire braid sleeve with attachment tails for connection to the underside of the access frame.

B. The pump and motor assembly shall have CSA Approval as one unit, per CSA Standard C22.2-108. Proof of this approval shall be submitted by the Pump Manufacturer to the Engineer with the approved Drawing. An approval of the motor unit only will not be acceptable.

C. The pump/motor unit shall also be approved by CSA for service in Class I, Division 1, Group D Hazardous locations.

D. The head-capacity curve shall have a single flow rate for each pumping head value and have a continuously rising head characteristic from the specified design point to shut-off so as to ensure stability and control in both individual and/or parallel operation.
The operating range of the pump, as specified, is defined by the maximum and minimum operating heads against which the pump will be required to operate. At no point on the pump's power demand curve between shut-off and the minimum operating head shall the pump's power demand exceed the rated power of the motor.

2.3 PUMP CONSTRUCTION

A. Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces. All exposed nuts or bolts shall be of Stainless Steel A 276 Type 316.

B. Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Viton rubber O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

C. Paint Standard: The exterior of the pump, including all metal surfaces coming into contact with the pumpage shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer and finished with polyester, epoxidized resin paint.

2.4 MOTOR

A. The pump motor shall be a NEMA-B design induction type with a squirrel cage rotor, shell type design and be housed in an air filled, watertight chamber. The stator windings and leads shall be insulated with moisture resistant Class H Insulation rated for 155°C (306°F). The stator shall be trickle impregnated with Class F Resin and shall be heat-shrink fitted into the stator housing providing for superior heat transfer. The motor shall be designed for continuous duty while handling pumped media of up to 40°C (104°F). The motor shall be capable of withstanding at least 15 starts per hour. The

rotor bars and short circuit rings shall be made of aluminum. Three (3) thermal switches shall be embedded in the stator ends coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

B. The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of ±10%. The motor shall be designed for continuous operation in up to a 40°C (104°F) ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C (176°F). A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

C. The motor efficiency shall not be less than 94% at the duty operating points.

D. The pump/motor unit shall be approved by CSA for hazardous location.

2.5 COOLING SYSTEM

A. Each unit shall be provided with an adequately designed cooling system. The water jacket shall encircle the stator housing, providing heat dissipation for the motor regardless of the type of installation. Impeller back vanes shall provide the necessary circulation of the cooling liquid through the water jacket. The cooling media channels and ports shall be non-clogging by virtue of their dimensions. The cooling system shall provide for continuous pump operation in liquid temperatures of up to 40°C (104°F).

B. The pump/motor cooling system shall be rated for continuous duty in a completely dry mode of operation. A closed loop, jacket type, cooling system shall be provided of sufficient size to handle all specified conditions of operation. The cooling system shall be completely sealed against the pumped media and be completely separated from the air filled motor housing. Heat dissipation shall be affected by the forced circulation of the cooling liquid (Glycol) across a heat exchanger arranged in the pump cavity. The cooling liquid shall be an environmentally safe antifreeze down to temperatures of minus 4°F (- 20 ° C).

C. Motors containing di-electric oils used for motor cooling and/or bearing lubrication or motors requiring the pumped media and/or externally provided fresh water to be circulated through a cooling jacket shall not be acceptable.

2.6 VOLUTE

A. Pump volute shall be single piece, grey cast iron, Class 35B, non-concentric design with smooth passages large enough to pass any solids that may enter the impeller.

B. Provide inspection port to check impeller condition or to unclog pump.

C. Flushing connection to facilitate cleaning of plugged lines or pump.

D. Air vent connection on high point of volute.

2.7 IMPELLER

A. The impeller shall be of grey cast iron, Class 35B, dynamically balanced, multi-vaned, double-shrouded, non-clogging design having a long through let without acute turns. Impeller shall be keyed to the shaft, retained with an expansion ring. All impellers shall be capable of handling solids, grit, fibers, sludge and other materials as may be normally found in wastewater.

2.8 PUMP SHAFT

A. Pump and motor shaft shall be the same unit. The pump shaft is an extension of the motor shaft. Couplings shall not be acceptable. The shaft shall be 329 Stainless Steel and shall be completely isolated from the pumped liquid.

2.9 WEAR RINGS

A. A wear ring system shall be used to provide efficient sealing between the volute and suction inlet of the impellers. Each pump shall be equipped with a duplex stainless steel insert that is drive-fitted to the volute inlet. This pump shall also have a duplex stainless steel impeller wear ring, heat-shrink-fitted onto the suction inlet of the impeller.

2.10 MECHANICAL SEALS

A. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating tungsten-carbide ring. The upper, secondary seal unit, located between the lubricant chamber and the motor housing shall contain one stationary, tungsten-carbide seal ring and one positively driven, rotating seal ring. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment and shall be capable of operating in either clockwise or counterclockwise direction of rotation without damage or loss of seal.

B. The seal system shall not rely upon the pumped media for lubrication. The motor shall be able to operate dry without damage while pumping under load. The seal lubricant shall be non-toxic, and FDA approved for potable water applications.

2.11 PROTECTION

A. All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. At 140°C (284°F), the thermal switches shall open, stop the motor and activate an alarm.

B. A lower bearing temperature monitor shall be provided.

C. A leakage sensor shall be included to detect water in the stator chamber.

D. The thermal switches, FLS and the lower bearing temperature monitor shall be connected to a CAS (Control and Status) monitoring unit. The CAS shall be designed to be mounted in the control panel.

2.12 BEARINGS

A. The pump shaft shall rotate on three, permanently lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The two lower bearings shall consist of one roller bearing for radial forces and one angular contact bearing for axial thrust.

B. The lower bearing housing shall include an independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut the pump down. Bearings to provide a minimum life of 100,000 hours.

2.13 PROTECTIVE COATING

A. The pump shall be coated with a two-component epoxy finish having at minimum 83% solids by volume. This coating shall be non-toxic and approved for both wastewater and water applications.

B. Name plates shall be masked or removed prior to surface preparation and coating. Polished parts and surfaces (shafts, couplings) shall not be painted but preserved against corrosion. The coating of stainless steel parts is not required but acceptable.

2.14 ACCEPTABLE MANUFACTURER

A. Xylem (Flygt).

B. Sulzer.

C. KSB.

PART 3. EXECUTION

3.1 FACTORY TESTING

A. Certified test curves showing performance characteristics of each pump shall be submitted to the Engineer before shipment to the site, which shall be submitted to the Engineer pump tests shall be conducted with the actual motor to be supplied.

3.2 INSTALLATION AND INSPECTION

A. The pumps and accessories shall be installed as indicated on the Contract Drawings, in accordance with the Manufacturer's written instructions and as approved by the Engineer.

B. Prior to startup, a Field Service Engineer employed directly by the Manufacturer shall inspect, operate, test, adjust and troubleshoot the installation. This work will ensure that the equipment has been installed properly, lubricated adequately, checked for soundness and ready to be started.

C. The Pump Manufacturer Field Representative, mentioned above, will certify that the equipment is ready for operation before use. In addition, the Field Service Representative shall instruct the City's Operation personnel in the proper operation and maintenance of the equipment supplied.

D. Inspection by a representative of the Manufacturer who is not a direct, full-time employee of the Manufacturer is not acceptable.

E. Provide for additional supervision of installation by Equipment Supplier as required.

F. Arrange with the Engineer a mutually agreeable date when the representative should be on site.

G. The Supplier shall allow sufficient days for supervision, commissioning and testing of installation and instructions to Plant Operator.

H. Submit a report, signed by the Manufacturer's Representative, describing in detail the inspection, tests, and adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance. The report must verify that the equipment conforms to all Specifications.

I. Inspection to include checking for:

1. Cracks and other damaged or defective parts. Each piece of equipment must be undamaged, without cracks and free of defective parts.

2. Completeness of installation as specified and as recommended by the Manufacturer.

3. Correctness of setting, alignment and relative arrangement of various parts of the system.

3.3 MECHANICAL TESTING AND CERTIFICATION

A. After startup and prior to final acceptance, the Contractor shall conduct Engineer-witnessed performance tests on the equipment.

B. A Field Service Representative will cause the pumps to perform all mechanical functions that they have been designed to perform. Tests will be scheduled with the Engineer at least two (2) weeks prior to the planned test date.

C. The Factory Trained Representative shall submit to the Engineer a written report stating that the equipment has been checked and is suitable for operation.

3.4 SUPERVISION OF INSTALLATION AND COMMISSIONING

A. Test and commission the equipment in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. At the completion of satisfactory installation, each unit shall be started by the General Contractor under the supervision of the Supplier and the Engineer. All controls and alarms shall be checked and tested to ensure proper control and equipment protection.

C. Equipment shall only be accepted after receipt of a satisfactory report submitted by the Manufacturer's Representative(s).

D. When the installation and operation is satisfactory, the Supplier shall certify in writing to the General Contractor that the unit is available for operation.

E. Modify or replace equipment or materials failing required tests.

F. Perform additional testing required due to changes of materials, and/or failure of materials or construction to meet Specifications at no extra cost to the City.

3.5 STORAGE

A. Prior to the installation, the pumps and accessories should be protected and stored indoors in a dry area, in accordance with the Manufacturer's recommendations.

3.6 MAINTENANCE

A. Provide maintenance on Supplier's material as required by the Supplier from the date of delivery to the initial startup.

TABLE 1: DATA FORM - FOR SUBMERSIBLE PUMPS

City of Greater Sudbury Project No. _____ Contract No. ISD24-169

Location Don Lita Lift Station

Notes:

1. This table covers the specific requirements of the equipment for the above project.
2. Complete Table 2 fully and submit prior to Shop Drawing Submittal.

PUMPS - GENERAL

No. of pumps required: 2
Pump Type:
Pump Application: Submersible Wastewater Pumps
Liquid Pumped: Sewage

PUMP MECHANICAL FEATURES

Maximum Speed (RPM): 1800 RPM
Service (continuous/intermittent): continuous
Lineshaft (carbon/stainless steel): stainless steel

PUMP OPERATING CONDITIONS

Design Point Capacity (each pump): 67± L/s
Design Point Total Dynamic Head (m): 27.7 m
System Head Curve Included (Yes/No): No

PERFORMANCE REQUIREMENTS

Maximum Motor kW: 33 kW
Minimum Efficiency: 76 %

SPECIAL REQUIREMENTS

It is required that each pump be equipped with a 150 mm Class 125 C.I. flange discharge. It is also required that each pump motor be equipped with leakage detection sensors and thermal overload protection (thermistors).

TABLE 2: DATA FORM FOR SUBMERSIBLE PUMPS

City of Greater Sudbury Project No.____Contract No. ISD24-169

Location: Don Lita St. Sewage Lift Station

Part 4. CONTRACTOR'S REFERENCE

Contractor's name, address and phone number:_____
Contractor's reference number and date: _____

CONTRACTOR'S PUMP DATA

Number of pumps: _____Pump Manufacturer: _____
Place of Manufacture:_____
Model Number and Type: _____
Speed: _____ rpm Performance Curve Attached:_____

Performance for each pump at or near design point:

Design Point 1:
L/s at _____m TDH
kW (HP)_____% Efficiency

Design Point 2:
L/s at _____m TDH
kW (HP)_____% Efficiency

Suction Diameter:_____ mm Discharge Diameter: _____mm
Size of Impeller: _____ mm Maximum Impeller Size:_____mm
Maximum Diameter of Solids:_____ mm
Weight of Pump/Motor: _____ kg

PUMP MOTOR DATA

Motor Manufacturer: _____

Place of Manufacture:_____

Model Number and Type: _____

Type of Motor Cooling System:_____

Nominal Rating of Motor:_____kW

Starting Inrush:_____ A Maximum Inrush: _____A

Voltage/Phase/Frequency: _____

Full Load Speed:_____ rpm

TABLE 2 (continued)

Temperature Rise at Full Load: _____° C

Permissible Number of Starts per hour: _____

Cable(s) to Motor for Power (and Sensor) - Type, length, conductor number and size: _____

_____

_____

Bearing Type at: Pump End: _____
Other End: _____

Average Bearing Life: _____

Nominal Bearing Operating Pressure: _____kPa (psi)

Painting Finish: _____

Submitted by: _____ Signature: _____

Date: _____

END OF SECTION

DIVISION 13

INSTRUMENTATION AND CONTROLS

INDEX

PART 1. GENERAL

1.1 INTENT

A. This Section contains items common to Sections of Division 13. The general requirements for the supply and installation of all process control equipment as specified herein and as shown in the Drawings are covered in this Section.

B. Read this Section in conjunction with other Sections of Division 13 and make sure the submittals and other requirements included in other Sections of Division 13 are followed in completing the work from the scope of this Division.

1.2 REFERENCES

A. This Section complements the requirements of Division 1. Comply and be responsible for all the requirements of this Section and of Division 1.

B. Refer to the Division 11 – Equipment, and the Division 16 – Electrical for additional requirements and instructions that apply to the work of this Section.

C. Refer to all other Divisions of the Specifications and these documents to determine their effect upon the work of this Section.

D. Have the material, equipment, installation and workmanship also meet the latest edition and requirements of the following:

1. Ontario Electrical Safety Code (OESC).
2. Canadian Standards Association (CSA).
3. Canadian Electrical Manufacturers Association (CEMA).
4. National Electrical Manufacturers Association (NEMA).
5. Electrical and Electronic Manufacturers Association of Canada (EEMAC).
6. International Society for Measurement and Control (Formerly the Instrument Society of America, ISA).
7. Electronic Industries Association/Telecommunications Industries Association (EIA/TIA 606).

E. All Instrumentation Signal Loop Diagrams as per ISA S5.1 and S5.4. Instrument identification and tag numbers/letters as indicated on Drawings.

1.3 LIST OF ABBREVIATIONS

A. The following table lists all acronyms, abbreviations, and their meaning in this document:

Name	Meaning
AC	Alternating Current
AWG	American Wire Gauge
CD	Compact Disk
CSA	Canadian Standards Association
DIN	Deusches Institut Fur Normung
EEMAC	Electrical and Electronic Manufacturers Association of Canada
EMF	Electro-Motive Force
FAT	Factory Acceptance Testing
FRP	Fiberglass Reinforced Plastic
I/O	Input/Output
ICP	Instrument Control Panel
ISA	Instrumentation, Systems, and Automation Society
MCC	Motor Control Center
NPT	National Pipe Tapered
OESC	Ontario Electrical Safety Code
PC	Personal Computer
PLC	Programmable Logic Controller
RS-232	Recommended Standard 232
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition
UPS	Uninterruptible Power Supply
VAC	Volts Alternating Current
VDC	Volts Direct Current
VFD	Variable Frequency Drive

1.4 SCOPE OF WORK

A. The work in this Section generally consists of, but is not limited to, the supply of materials, labour, equipment, permits, etc. necessary for a complete, integrated, operational instrumentation and control system for the City of Greater Sudbury – Don Lita Lift Station Upgrades and integrate it into the SCADA network, as is shown in the Contract Specification and Drawings.

B. In general, the work involves the supply, installation, modification and commissioning of the necessary hardware to monitor and control the facility as indicated on the Drawings and Specification sheets. The control platform is the Allen-Bradley family of processors, where all automatic control tasks are implemented. The supervisory level is GE iFix, where functions like operation, monitoring and data logging are fulfilled. The PLC in the ICP will communicate back to the central automation network via the existing fibre optic SCADA network.

C. Modify and/or remove existing equipment as shown on the Contract Drawings. The existing ICP Panel Drawings, PCN, SCADA Operation Manuals and SCADA Screens are available at City of Greater Sudbury for reference.

D. Coordinate removal and/or modification activities with other Divisions. As shown in D Series (demolition and upgrade) Drawings, disconnect and remove all control and power wiring connected to the existing PLC panel located at Don Lita Lift Station. Refer to the Process and Electrical Contract Documents for further demolition and upgrade details. Removal work shall be scheduled according to the construction sequencing and in coordination with Contract Administrator and City Operations. The Contractor shall carefully remove all existing instruments shown on the Contract Drawings, salvage, identify, provide the details in a list format with tag numbers and store the products that are to be reused and deliver other items to the Contract Administrator. Coordinate with the Contract Administrator prior to removing existing device or modifying the existing wiring or terminating wiring of new devices to the existing equipment or control panels. The existing facility shall be functional all the time. All related work and any requirements for shutdowns to be coordinated with the city operations. Comply with the construction sequencing and staging requirements indentified in the Section 01501 – Suggested Construction Sequencing. Coordinate removal and/or modification activities with other Divisions.

E. The Contractor is responsible for gaining a comprehensive understanding of the new and existing process and control equipments. During the field commissioning of the process equipment and the control and instrumentation equipment, the Contractor is to coordinate with the other Trades people and Suppliers, including Programmers, to facilitate the hardware and software commissioning.

F. Inspect the installation of equipment, which is to be connected to the ICP Control Panel, or supplied under this and other sections, and determine the source of any problems. Provide a written report with recommendations for remedial action if the equipment is not operating satisfactorily or not installed according to Manufacturer's instructions.

G. Provide all necessary equipment, tools, labour, etc., for installing and testing all equipment supplied under this Division.

H. The following is a summary of the major work:

1. Provide, install, test and commission one (1) new ICP panel (ICP-3000), associated field I/O wiring and programming intended for PLC and SCADA monitoring and control of the Don Lita Lift Station.

2. The new ICP panel shall be equipped with UPS and accessories including UPS maintenance by-pass switch. Provide UPS power to the all field instruments as shown on the Drawings and documents or as required.

3. The ICP panel shall be connected via existing fibre optic to the SCADA Network. A new Avaya Network Switch will be free issued by the City with four (4) months advance notification. Network Switch to be mounted inside the ICP panel.

4. Provide new instrumentation as per the Instrument List contained in the Appendix 1 of this Section and Contract Drawings.

5. All PLC programming work to be completed by the City of Greater Sudbury SCADA System Integrator, in accordance with Appendix 2-1 – Process Control Narrative.

6. All HMI SCADA programming work to be completed by City of Greater Sudbury.

7. The SCADA System Integrator will coordinate with the City of Greater Sudbury SCADA group for all HMI SCADA related work.

8. Coordinate with City of Greater Sudbury SCADA group a Test Plan for the PLC/SCADA software Factory Acceptance Test (FAT). Submit the Test Plan to the Engineer for approval. The FAT cannot be scheduled until the Engineer has reviewed the Test Plan from the Contractor and has approved it for use during the PLC/SCADA FAT.

9. Carry out the PLC/SCADA FAT Test Plan. Demonstrate functionality of PLC and SCADA software together. Supply all hardware/software required to run the PLC and SCADA software in automatic mode and to simulate conditions in the field. This includes feedback of digital outputs to corresponding digital input status bits. Feedback of analog output commands to analog input measurements, and simulation of process measurements, and discrete detection devices. Demonstrate control system compliance with the process control narratives. Demonstrate the SCADA system graphical response to all simulated field equipment. Notify the Engineer ten (10) business days in advance of the PLC/SCADA FAT to ensure that the testing is witnessed by the appropriate parties.

I. Control Panel:

1. Provide new Instrument Control Panel (ICP-3000) for the Don Lita Lift Station as specified in Appendix 1-2 – Product Data Sheets.

2. Provide a Test Plan for the panel Factory Acceptance Test (FAT). Submit the Test Plan to the Engineer for approval. The FAT cannot be scheduled until the Engineer has reviewed the Test Plan from the Contractor and has approved it for use during the FAT.

3. Carry out the FAT Test Plan. Demonstrate continuity of all wiring from ICP terminal blocks to PLC addresses within a suitable “dummy” or “shell” PLC Program. Notify the Contract Administrator ten (10) business days in advance of the PLC/SCADA FAT to ensure that the testing is witnessed by the appropriate parties. The Dummy Program must be used as a starting point for the custom PLC Program, and for verification of field I/O during the SAT.

4. During the construction phase of the project, programming of some software interlocks and other temporary update of PLC and SCADA programming to be implemented to maintain the continuous operation of the plant. Any such temporary changes shall be restored back to its original programming status.

5. Contractor is responsible to produce SCADA Users Manual for the entire scope of work under this Contract. Contractor shall carry out any necessary updates required to existing SCADA Users Manual impacted by the scope of work under this Contract. The SCADA User's Manual shall be scheduled to submit with other documentation for the Substantial Completion Inspection for the Construction Contract.

6. Provide field wiring, setup/calibrate, test, commission and place into successful operation the ICP panel.

J. Field Devices:

1. Contractor to visit the site and trace out the existing instruments, equipment and related control wiring. Contractor is to review and note the existing functionality.

2. Provide, wire, calibrate, test and commission all field instrumentation, ICPs, and control system hardware including all peripheral devices necessary.

3. Provide all field device tags and panel labels listed in the Appendix 1-1 – Process Equipment List.

4. Provide configuration and programming for all microprocessor based equipments including single loop or multi-loop controller, analyzer, and other intelligent instruments.

5. Provide all interconnecting cabling between controllers as required.

6. Commissioning:

   a. Comply with the requirements set out in Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

   b. Any relocation and rewiring activities shall be closely reviewed with the Contract Administrator and fully coordinated with the Plant Operations staff. The relocation and reconnection of instruments shall be scheduled, planned carefully and pre-approved by the Engineer as well as the plant operations staff. Removal shall be carried out in such a way that shall minimize the interruption of the process operation.

   c. Carry out all commissioning tasks detailed in Part 3 of this Document (Execution).

1.5 GENERAL REQUIREMENTS

A. Ensure the continuous operation of the plant and parallel operation of the existing control system.

B. At all times, ensure that work being carried out by the Engineer, or the Plant Operations staff is properly coordinated with all ongoing construction activities and are unhampered by unnecessary delays or obstructions.

C. All functionality described in the documents shall be fully implemented.

D. Demonstrate operational equipment and put all equipment into operational service to the satisfaction of the Engineer.

E. All equipment performance requirements shall be based upon worst case scenarios.

F. Provide documentation in timely manner and as specified.

G. Safeguard Against:

1. Problematic Hardware: Unstable hardware triggered by hardware or device driver conflicts, component substitutes that deviate from specifications or fail to meet mission critical performance criteria, including unauthorized tampering with computer operating system or application setup parameters. Any of which create additional setup time for the Engineer and expand resources.

2. Unprepared SCADA/PLC FAT: Noncompliance with control narrative, simulation hardware/software failures, noncompliance with the process control narrative, and noncompliance with the Test Plan.

3. Unprepared ICP FAT: Noncompliance in panel assembly, noncompliance with the Test Plan, noncompliance with this document or its appendices, substandard workmanship or poor preparation prompting the Engineer to reject the FAT and thereby having to reschedule further sessions.

4. Unprepared Commissioning & SAT: Incomplete loop checks, instrument calibration, wire or installation, noncompliance with the test plan, noncompliance with this document or its appendices, thus requiring an inordinate amount of repeat site visits causing unnecessary delays.

5. Unresolved Maintenance Issues: Critical instruments, Control hardware, motor starters and valve actuators, and all essential works required for the facility to run in a safe and fully automated fashion, must be kept in proper working order at all times. Resolve all maintenance obligations in a timely fashion to avoid unnecessary operator overtime incurred by the Client or causing the Client or Engineer to seek out direct assistance from your Suppliers or local Trades. This applies during initial stages of commissioning and throughout the maintenance warranty period.

1.6 RELATED WORK SPECIFIED IN OTHER DIVISIONS

A. Division 1 – General Requirements.

B. Division 11 – Equipment.

C. Division 16 – Electrical.

1.7 SUBMITTALS

A. Submittals to be in accordance with Section 01330 – Submittals.

B. Drawing Index: Prepare a clear, typed index listing the number and title of all proposed Purpose-Made Drawings and submit for review within ten (10) days after award of Contract.

C. Wherever there is a discrepancy between information provided in this document and on a Drawing, the Contractor must submit a Request for Information (RFI) to the Engineer in writing.

D. Milestone Schedule: Prepare and submit a proposed schedule of instrumentation and control work per General Conditions, indicating the following major milestones as a minimum. Properly sequence all milestones providing a reasonable timeframe for each item:

1. Hardware Shop Drawings submission – including initial issue of Product Data Sheets.
2. Preliminary issue of Operating and Maintenance Instruction Manual.
3. FAT/SAT Test Plans.
4. SCADA/PLC Program FAT.
5. ICP FAT.
6. Signed calibration sheet or report on each field instrument.
7. Report on proper site installation, inspection, and loop check.
8. Site Acceptance Testing (SAT).
9. Final submission and sign-off of Product Data Sheets as per this Section.
10. Maintenance training sessions on filed instruments.

E. Purpose-Made Drawings:

1. Prepare Purpose-Made Drawings neatly and accurately by means of the latest version of AutoCAD or as otherwise advised. Do not use external references or customized file extensions. Provide fully portable electronic file copies of all Drawings.

2. Make submissions on reproducible material such as mylar, vellum or legal-size paper, complete with a title block containing the Engineer's E.O. number, your Contract Number and company logo, a Drawing and Contract Title as stated in the Contract Drawings, and a referenced Drawing Number (related to a file name if applicable). Provide tabular columns to record the original submission date, a revision number, date and reason for subsequent revisions, and signature of authorized issuing staff member.

3. Submit, as a minimum, the following Purpose-Made Drawings:

    a. Scaled, referenced, front of panel layouts, and General Arrangement Drawings.

    b. Scaled, referenced, internal panel layouts (may be combined with the above).

    c. Equipment and/or panel block wiring diagrams showing termination identification at each item of equipment, inter-wiring and cable numbering, all peripheral equipment, any PLC module DIP switch settings, pin assignments for D-shell connectors, plugs and jacks, and instrument/equipment tag numbers.

    d. Where issued, Loop Drawings are typical for guidance only.

    e. Submit itemized Instrument Wiring Arm Drawings for all analog process loops and discrete connections, generally in accordance with ISA S5.4 format and as a minimum incorporating the following details: PLC terminal numbers, ICP terminal numbers, field terminal numbers, wire numbers, contact orientation, power source identifications and equipment numbers. The "AutoCAD" files for these Drawings are to be edited with "Record Drawing" detail and made accessible to the Engineer during the Contract.

    f. List of expendable materials and quantities.

    g. List of Instrument, Equipment and Panel Identification Nameplates.

F. Vendor Equipment Shop Drawings:

1. Submit Shop Drawings for all field and panel mounted instruments, controllers, gauges and similar products. Manufacturers' documentation will be accepted only if the following information is clearly indicated and highlighted for the equipment proposed. Submit the following:

    a. An itemized quotation from the proposed instrument or equipment vendor, (prices removed), including tag numbers, quantities, options being provided and a full description and performance data.

    b. Installation details depicting mounting assemblies, physical dimensions, process connection sizes (e.g., flange ratings and styles).

    c. Termination details clearly indicating the type and lengths of external wiring required and electrical connections.

    d. Power supply rating, input and output signal ranges, maximum measured process range and calibrated scale, physical, electrical and environmental requirements.

    e. Exact catalogue model numbers for each piece of equipment and its accessory options, and clearly referenced by the respective instrument or equipment tag name given in this document (improperly tagged items shall be rejected).

f. A separate sheet with Manufacturers' recommended list of spare parts including individual pricing with the Shop Drawings.

2. Contractor shall note compliance and variance in writing, or the Specification shall have precedence over approved Vendor Drawings. Stamp the Shop Drawings submitted as either "COMPLIES EXACTLY WITH SPECIFICATION" or "DEVIATES FROM SPECIFICATION" as appropriate. In the latter case, describe deviations exactly and indicate how they impact the specified duty of the component.
The Engineer will assess acceptability of submission.

3. Initial submission for review to accompany Shop Drawings:

   a. The Product Manufacturer and the Supplier or Representative.

   b. The complete model or catalogue number(s) including any special options.

   c. The available adjustment range(s) and the Contract operating range(s).

G. Product Data Sheets:

1. Product Data Sheets specifying instruments and equipment form part of this document complete the blank spaces on these sheets with the information noted below and any other data pertinent to the equipment and the application.

2. Second Submission during pre-commissioning, testing and calibration period:

   a. Serial numbers, part numbers, dates of installation and calibration.

   b. Any special procedures required to duplicate calibration.

   c. This submission is for signature by the Contractor and the Engineer following acceptance of the operation of each instrument.

3. Final Submission of signed-off Product Data Sheets included with Operating and Maintenance Instruction Manuals:

   a. All of the above information.

   b. Phone and fax numbers of contact person for product support/service.

4. Where there is any discrepancy, the description provided on the Product Data Sheet takes precedence over the model number given in the data sheet.

H. Record Copies of Purpose-Made Drawings & Electronic Files:

1. Submit six white print "As-Built" copies of each Purpose-Made Drawing and document specified above, as well as electronic copies (on CD or comparable media). Under certain circumstances during the course of the Contract, instead of paper, Drawing and document files may be exchanged with the Engineer to streamline coordination.

I. Submission Format:

1. A complete set of Purpose-Made Drawings, Shop Drawings, and the initial submission of the Product Data Sheets shall be bound into one volume and issued for approval before the commencement of work.

1.8 INSTRUMENT AND EQUIPMENT MANUFACTURERS

A. When a product is specified without the words "or approved equal" an alternative or substitute product will not be accepted.

B. Design is based on the first named Manufacturer. If the Contractor proposes the use of a product other than the first named, and the submission is accepted; if some redesign is required, it shall be completed by the Contractor at no additional cost to the Contract.

C. For the purposes of limiting support costs and maintenance costs, use one Instrument Manufacturer/Distributor for as many products as is practical.

1.9 INSTRUMENT AND CONTROL SUBCONTRACTOR

A. Unless otherwise specified, the supply and installation of instruments, Instrument Control Panels (ICPs) and control system hardware, including testing, calibration, commissioning must be performed as a complete package by an experienced, reputable Instrumentation and Control Subcontractor. Include for Service Technician qualified by the Manufacturer to be on site if requested by the Engineer, or if correct methods for installation, setup and calibration are uncertain. Unless otherwise specified, only the Manufacturer's Technicians are acceptable where analyzers, gas detection system, or flow meters are concerned. This includes subcontracting main Suppliers and their services as necessary, and especially if called for in the Specification.

B. Submit to the Engineer documentation verifying that the company proposed as Instrumentation and Control Subcontractor is experienced in the instrumentation and control work and is capable of properly carrying out that work. Documentation is to include a list of at least five (5) similar projects successfully completed, as well as the Consulting Engineer and the name of their Site Representative for each project. Acceptance or rejection of a proposed specialist company rests solely with the Engineer.

C. All on site control and instrumentation work is to be performed under the direct supervision of a qualified and experienced supervisor employed by the Instrumentation and Control Subcontractor.

1.10 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

A. In addition to requirements for Operating and Maintenance Instruction Manuals specified in earlier sections, include the following:

1. Manufacturer's hardware and distribution software manuals.

2. Special instructions or procedures, including package systems, software and instrument trouble-shooting techniques.

3. Systematic procedures for operations personnel to start up, shutdown, manually override and locally operate all related equipment in accordingly titled manual Sections.

4. Recommendations on equipment maintenance and suggested spare parts.

5. Final Shop Drawings and signed-off Product Data Sheets as defined in this Specification.

6. Record copies of all Purpose-Made Drawings (as-built).

7. Name(s), address(s) and telephone number(s) for local qualified system and/or Product Service Representatives.

8. Calibration certificates from the Manufacturers for each calibrated instrument.

9. Manufacturer's certification of installation documents.

10. Certified network test reports.

B. Provide Operating and Maintenance Instruction Manual for Instrumentation & Controls in a separate indexed and tabbed manual, or separate indexed and tabbed section of the overall manual binder. Arrange sections in a logical, concise manner, and provide a cross- reference to enable all equipment/instruments to be located from its correct ISA tag.

C. Prior to submission of Final Operating and Maintenance Instruction Manuals, and at least 30 days prior to instrumentation and control system testing and commissioning commencing, submit to and review with the Engineer, two (2) copies of the proposed data for the instrumentation and control work Section of the Operating and Maintenance Instruction Manuals.

D. The delivery of manuals must be complete prior to application for a Certificate of Substantial Performance of the Work.

PART 2. PRODUCTS

2.1 INSTRUMENT GENERAL REQUIREMENTS

A. General requirements applicable to instruments are as follows:

1. Unless otherwise shown or specified, enclosures for all instruments located indoors in dry non-hazardous areas are to be as a minimum EEMAC 12.

2. Unless otherwise shown or specified, instruments located outdoors must be suitable for the surrounding climate and appropriately installed with:

   a. A EEMAC 4X enclosure including gasketed windows for displays, containing a thermostatically controlled heater and disconnect switch – minimum typical enclosure to be an O Brien VIPAK series or equal.

   b. A combined rain/ice/snow protection shield and sunshade for all electronic instruments which are already provided with sturdy, heated EEMAC 4X enclosures by the Manufacturer. Supply tip-up type hoods for access for routine calibration and maintenance.

   c. Drawing submissions must clearly show the enclosures proposed for each instrument.

3. Electrically heat traced sensing lines for instruments with sensing lines liable to freezing.

4. Unless otherwise shown or specified, provide instruments located in hazardous areas with Canadian Electrical Code ratings for Class, Group, and Division as shown.

5. Unless otherwise shown or specified, provide instruments located in areas subject to flooding with submergence rated enclosures.

6. All line voltage powered instruments are to be suitable for a 120 VAC power supply. Any line voltage AC powered instrument not CSA certified must bear an Ontario Hydro Special Approvals Branch label.

7. Normal instrument and control power supply for the Contract is 120 VAC. Emergency power supply is from associated UPS. Provide all line powered instruments suitable for use on these supplies with appropriate CSA Approval.

8. As applicable, instrument control output is to be from 4 to 20 mA, linear, isolated, capable of driving a maximum load of 750 ohms, unless otherwise specified.

9. Provide all the necessary mounting hardware, electrical connections, transducer junction boxes, power supplies, and all accessory items or options required to satisfy each application.

10. Provide equipment made of appropriate materials for the service indicated on each Instrument Specification Sheet, and for the process fluids present, which all exposed equipment and materials must withstand.

11. Provide corrosion resistant stainless steel screws, bolts, fasteners etc. in all applications.

12. Provide all special instrumentation communication cables, transducer cables, power cables, process sensing/sampling lines and capillary tubing in field measured lengths without joins as required by Manufacturer. Allow adequate cable/capillary etc., to allow removal of instrument/transducer from process. Agree instrument-mounting locations with Engineer to ensure accurate field measurements.

13. Provide mechanical protection for capillaries and transducer cables and adequately secure to eliminate sagging.

14. Provide suitable shields, stilling wells or mounting plates to protect transducers.

15. Instruments on liquid service shall be mounted below sensing lines, with process tapping points taken from the side of the process line.

16. Instruments on gas service shall be mounted above the sensing lines, with process tapping points taken from the top of the process line.

17. All instruments shall be provided with process isolation valves. Valves must be utilized on all instrument lines for easy removal without disruption to the process.

18. Local indicators must be provided for all transmitters. Local indicators shall read as follows:

    a. Temperature - Direct reading in ºC

    b. Level - 0 – 100 as a percentage (%) of calibrated range

    c. Flow - Direct reading in m^3/sec

    d. Pressure - Direct reading in kPa and psi

19. Where manual operation of valves is required, based on a transmitter signal value, the indicator should be located adjacent to the valve or equipment local control panel.

20. Supply any spare part required to commission instruments. Include five (5) spare fuses of each type in the Instrument Panel.

B. Purchase all equipment via official Ontario distribution channels that are authorized to sell, service, and support the equipment and have the responsibility to warranty its performance. Equipment that bypasses the Manufacturer's authorized distribution channels is not acceptable. The Contractor is responsible for any costs associated with return, repair and/or replacement of equipment later discovered to be obtained in such a way.

C. Supplied instruments should be of current design. Obsolete equipment or equipment that has been identified for withdrawal from the market by the Manufacturer before date of Substantial Performance of the work shall not be accepted.

D. Supplied equipment should be new and of best quality. No used or reconditioned equipment will be accepted.

E. In addition to the insurance coverage required in the General Conditions, provide insurance coverage against theft or damage for any equipment turned over to the Engineer/Client during transit to and from the place of delivery and for the period when the equipment remains on the Engineer's/Client premises. Maintain coverage until equipment returned to Contractor or installed.

F. Replacement electronics, sensors and transmitters to be stocked locally.

G. Non-stock hardware should be available no longer than three (3) days.

H. On-site technical support should be available within 24 hours.

I. All hardware remains the responsibility of the Contractor to provide a fully functional control system.

2.2 INSTRUMENT AND SENSING TUBING CONNECTIONS TO PROCESS LINES

A. It is assumed that the first sensing/sample line (root) isolation valve is part of Division 11 or 15 work. Where an instrument is distant (> 5 m) or not visible from the process tapping point, provide isolation valves local to the instrument, appropriate for the process fluid.

B. Provide process sensing/sampling lines of 316 S. S. tubing, minimum diameter of 12 mm (1/2") adequately supported and protected throughout its length. Compensate for relative movement between process pipe and instrument via a coiled or flexible sensing installation where application requires this (vibration, high temperature etc.).

C. Use full length tubing and minimize fittings and unions as much as possible.

D. Provide test/calibration connection with isolating valves and removable end-caps between pressure sensing instruments and root isolation valves. Test connection must be easily accessible.

E. Locate all drain plugs below the lowest tube fitting, union or valve. Slope horizontal tubing toward drain plug by minimum 1 cm per meter. Provide drain plugs on all tubed instrument systems.

F. Provide tubing and tube fittings from Swagelok (Avon Valve and Fitting Co. (416) 438-1239).

2.3 INSTRUMENT PANEL REQUIREMENTS

A. In addition to specific panel requirements set out in the Product Data Sheets, general requirements for control panels and enclosures include:

1. Where ICPs are free-standing cabinets in electrical rooms in proximity to MCCs, provide ICPs that match the MCC enclosures in height, depth, finish, where possible and with a minimum EEMAC12 rating unless otherwise specified.

2. Supply power to instruments from the ICPs. Protect each instrument power circuit with a panel mounted terminal block type circuit breaker sized to suit.

3. Provide all EEMAC 4X outdoor panels in stainless steel. Field junction boxes are to be EEMAC 4X.

4. Provide doors with continuous piano hinge with removable pin and oil resistant cellular neoprene gasket secured by gasket retainers. Door handles to be recessed type, lockable with key numbers, co-ordinated by area to reduce the quantity of keys.

5. Provide lamicoid nameplates for all equipment, both door mounted, and panel mounted.

6. Provide 150 mm concrete base for floor-mounted panels unless otherwise indicated and provide spacing of 50 mm minimum between rear of panels and external walls, to avoid effects of possible condensation. All floor mounted units to have stainless steel spacers between panel and wall.

7. Provide all wall-mounted panels with 50 mm stainless steel spacers and incoming field cables.

8. Do not allow panel floor mounted equipment (i.e., UPS) to block access to the panel back plane mounted equipment.

2.4 CONTROL PROCESSORS – PLCS, ETC.

A. Control related equipment is to be housed in EEMAC enclosures suitable for the application and environment, and as a minimum are to be EEMAC 12. ICPs are to have fully hinged doors and key locks matching the Engineer's existing panels (if any).

B. Provide all software associated with the new PLCs licensed to the Client, on original storage media in original storage packaging.

C. Provide all cables, line extenders and connection devices required for the connection of the system and for connection of any associated programming or operator interface devices. Provide double insulated cables unless otherwise specified. Select and provide connectors with electrical contact surfaces gold-plated and D-shell connectors with metal or metalized plastic (shielded type) hoods.

D. Provide components rated for continuous service under the following conditions:

Temperature	-	0 to 50°C
Relative Humidity	-	5 to 95%
Vibration	-	0.25G from 5 to 100 Hertz
MTBF/MTTR	-	> 100,000 hours/3 hours

E. Provide a written confirmation from the Manufacturer of each product stating that it is a current product and that it will be supported (spare parts, software drivers, service, etc.) for a period of not less than five (5) years from the date of purchase. Submit confirmation with Shop Drawings.

F. For all motor Start/Stop commands and actuator Open/Close commands use only individually isolated relay output modules.

G. Always install signal isolators for VFD analog signals in the ICP.

2.5 WIRE AND CABLE

A. All wire and cable must be sized and installed in accordance with the OESC Requirements. No control wire smaller than No. 14 gauge shall be used except where so indicated on the Drawings or as specified in other Sections.

B. No control wire smaller than No. 14 gauge shall be used except where so indicated on the Drawings or as specified in other Sections.

C. Supply shielded cables in conduit as follows:

1. Supply single pair shielded cables with 600 volt insulation; No. 16 AWG twisted stranded copper, equal to Belden 1118A.

2. Supply multi-paired shielded cables individually shielded, complete with overall shield, No. 18 AWG, 600 volt insulation, equal to Belden 1051.

3. Provide Teck armoured equivalents of the above cables for cable tray applications.

D. Provide all concrete coring between floors as required.

E. Provide adequate slack on cable harnesses to permit easy removal of I/O and other printed circuit cards and/or modules and instruments during service or repair.

F. All feeders shall be run in continuous lengths between power supply point and the load with no splices.

G. All wiring for signal system shall be identified as to circuit numbers with approved markers on the cables at all panels and terminal strips. Where handwritten markers are necessary, use the Manufacturer's recommended indelible marker pen. Printing must be neat, capital alpha characters.

H. Group markers shall be used for major groups (e.g., all signals from an MCC starter.).

2.6 EXPENDABLE MEDIA

A. For any instrument or system peripheral which uses expendable media such as recorder chart paper, printer paper, diskettes, analyzer reagents and membranes, filters, etc., supply enough media sufficient for one year of operation from the date of Substantial Performance of the work and deliver the media to the Engineer prior to application for the Certificate of Substantial Performance.

2.7 PRODUCT DATA SHEET AND DEVICE DATABASE

A. Product Data sheet are issued with and form a part of this Section. See Appendix 1-2 of this Specification.

B. Device Database including Device List, Device Control Wiring List and Product Data Sheet, are issued with and form a part of overall Technical Specifications.

PART 3. EXECUTION

3.1 COORDINATION

A. Carefully examine and monitor for compatibility, any instrumentation and control work provided as part of the work of this Section or any other section, or the Client and ensure that all trades involved are aware of any coordination problems or details.

B. Incompatible work, such as instrument process connections, mounting of equipment, analog, discrete or communication wiring, voltages, or inconsistencies resulting from insufficient coordination of other related work, is to be satisfactorily resolved at no additional cost to the Contract.

C. When scheduling site inspection, ICP FAT, PLC/SCADA FAT, commissioning, or SAT with the Engineer, allow at least ten (10) working days advance notice.

3.2 MANUFACTURER'S SERVICE AND CERTIFICATION OF INSTALLATION

A. Comply with the requirement of Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

B. Allow in the tender for all the necessary services and expenses of a trained, qualified Manufacturer's Representative for each device as specified in the specification sheet, to ensure correctness of installation, testing, start-up, commissioning and training.
The qualified representative is to:

1. Provide onsite supervision of installation for the initial and critical stages of the work as agreed to with the Manufacturer/Supplier and as required by the Engineer.

2. Supervise testing of equipment. Supervise retesting of equipment at no additional cost to the Client.

3. Provide written certification stating that the work has been completed satisfactorily.

4. Provide a complete installation, start-up checklist and sign off on the start-up work completed.

5. Provide operation and maintenance instruction to the Client Operating staff.

C. Provide supervision of installation as required by the Manufacturers for all equipment in this Division. The Client Engineer may order additional supervision at no cost to the Client if, in their opinion, installation procedures are compromised.

D. Provide all materials, labour and equipment to make any adjustments to the installation as required by the Manufacturer or the Engineer to effect performance.

E. On completion of installation and testing, obtain certification from the Manufacturer that the equipment is installed correctly, is in full operating condition, and is operating in accordance with its design rating. Submit the original certificate to the Engineer.

F. Include the service of the trained personnel to inspect and commission the equipment when ready for starting and to instruct the operating personnel in the operation and maintenance of the equipment. Time spent on site by the trained personnel must be witnessed by the Engineer.

G. Include above services for all equipment specified in relation to this Section and as a minimum provide commissioning and training as follows:

1. Major Process Equipment – See the list below. Split the specified time into three (3) Stages: Inspection during installation, start up and commissioning, staff training.

2. Two (eight (8) hour) days for all other process instruments, where not specially mentioned, of which 0.5 day minimum dedicated to training.

H. As a minimum requirement, allow for in the Tender Price, the following days for the service of a Manufacturer's Representative. Not all days will necessarily be concurrent. If additional days are required to complete the work, include these additional days and trips in the Tender Price.

1. Uninterruptible Power Supply 1 day.

3.3 INSTRUMENT CONTROL PANEL INSPECTION & FACTORY ACCEPTANCE TESTING (FAT)

A. Make all of the necessary arrangements with Equipment Supplier(s) for panel inspection and ICP FAT prior to delivery.

B. Schedule the ICP FAT session(s) with the Contract Administrator a minimum of ten (10) working days in advance. Allow enough time for thorough testing and corrections to take place.

C. ICP FAT is to be performed in the presence and to the satisfaction of the Engineer and is to include all devices necessary to simulate actual operating conditions.

D. Configure the PLC(s) within the ICP, with a suitable "Dummy" or Shell Program, establish communication, temporarily wire digital inputs to test switches and digital outputs to indicating lights, analog inputs to 4-20mA generators and analog outputs to multimeters to demonstrate functionality of all hardware and software. Exercise the I/O within the "Dummy" PLC Program to demonstrate proper operation of all panel wiring and connected devices.

E. Make the necessary corrections as indicated by the tests, or as directed by the Engineer. Shipment of equipment to site is contingent on the Engineer's approval.

3.4 GENERAL INSTALLATION REQUIREMENTS

A. Unless otherwise specified, install and calibrate instrumentation and control system hardware in strict accordance with the Manufacturer's instructions and/or recommendations.

B. Advise the Engineer of any perceived problems regarding implementation of installation details or standard practices for the particular Contract application in sufficient time to avoid delays to the Contract.

C. If any requirements of this Specification, or a Drawing detail, contradicts the equipment Manufacturer's instructions or recommendations in a manner, which could be detrimental to its operation, including the possibility of inducing adverse side effects elsewhere to the system, immediately notify the Contract Administrator in writing and refrain from installing until the problem is resolved.

D. Confirm the correct locations for equipment with the Engineer prior to installation and/or roughing-in.

E. Supply any materials and/or test facilities necessary for commissioning. The use of the Client facilities, if suitable, may be considered upon written request.

F. Prior to the shutdown of any operating equipment, provide a written notice 48 hours in advance to the Client. Shut down of equipment is limited to a length of time determined by the Client. Make all arrangements to minimize down time.

3.5 INSTALLATION INSTRUMENTS

A. Install, test, calibrate and commission instruments in accordance with this Specification, Drawings for construction and any special details where they apply. Where installation details are not indicated, conform to the Manufacturer's instructions.

B. Unless otherwise shown or specified, all required mounting hardware, enclosures, terminations, junction boxes, etc., are to be provided. Refer to the Tender Drawings and the Manufacturer's documentation to confirm the necessary hardware and construction for specific mounting assemblies where such details are not specified herein.

C. Do not mount instruments on vibrating structures (e.g., handrails), or on piping or near equipment that induces vibration. Do not mount instruments below or directly adjacent to lines conveying corrosive chemicals or near sources of leakage or spillage.

D. Prepare metal surfaces and paint supports or frames the same colour as the member the complete assembly is mounted on.

E. Locate instruments and their associated sensors, local isolation valves, isolation switches and other related accessories so that they are readily accessible for operation, maintenance or removal. Ensure that instrument displays are properly oriented so as to be easily viewed. Unless otherwise shown or specified, mount instruments 1.4 m above finished floors, grade or platforms. Allow for cabinet plinth/floor-pad heights when locating panel instruments. Any instrument that is not easily accessible for operation or maintenance, or any indicator that is not easily and readily visible must be relocated as directed by the Engineer at no charge to the Contract.

F. When drilling or installing conduit entry points in instruments, protect internally mounted equipment from vibration, shock and metal filings. Conduit entries must maintain the equipment or panel EEMAC rating.

G. Field measure lengths for transducer cables, and similar items prior to ordering. Mechanically protect cables and adequately secure in place without sagging.

H. For location, power, mounting and other related details, refer to the Manufacturer's installation details and to the Instrument and Electrical Drawings issued for construction.

I. Provide isolation valves for all instruments.

J. Protect all instruments with capillaries throughout their length without sagging, by using painted/galvanised angle iron and clips. Avoid sharp bends in capillary and coil any excess close to the sensor end. Protect the coiled capillary by clipping to a steel plate or other safe method.

K. Sensing and sample lines are to be run in 1/2" stainless steel tubing with "Swagelok" compression type fittings.

L. Electrically heat trace all instrument sensing and sample lines liable to freezing.

M. Install process sample piping and sensing lines to avoid accumulation of vapour or gas (in liquid service) and of liquid or condensate (on vapour or gas service) as appropriate.

N. Position instruments so that they do not block or obstruct walkways or access points and provide adequate space around installation for removal of covers, etc.

O. Standard instrument process connections of 1/2" NPT female are to be provided (Pressure gauges normally 1/2" NPT male).

P. Instrument support brackets may not be welded to process piping or equipment but should generally be pedestal or wall mounted.

Q. Run field cables for analog signals in separate conduit from 120VAC/24VDC control or 120 VAC power supply cables.

R. Use field junction boxes suitable for the area classification to "marshal" groups of signals of the same type in an area and cable back to buildings and local control panel with multicore cables.

S. Junction boxes may be FRP or similar material suitable for the area and rust and weather resistant. Terminals inside field junction boxes are to be DIN rail mounted.

T. Provide the necessary mechanical shields, mounting plates to properly secure and protect transducers. Provide stilling wells wherever turbulence can adversely affect measurement.

U. Once an instrument has been inspected by the Engineer and initially calibrated, it is to remain powered up at all times unless servicing the instrument itself. Immediately install keepers on all panel circuit breakers powering instruments.

V. Instrument calibration, set points and other programmable parameters are to be confirmed with the Engineer during on-site inspection as soon as site conditions are sufficiently ready. Final calibration values may and will be different than nominal values specified in the Product Data Sheets at no extra cost to the Contract.

3.6 INSTALLING CONTROL EQUIPMENT

A. Install, test, and commission controllers in accordance with requirements of this Specification, Drawings for construction, and any special details as they apply. Where installation details are not indicated, conform to the Manufacturer's instructions.

B. Install PLC and other related peripherals in EEMAC panels as indicated on the Drawings. Mount floor-standing panels on a 150 mm (4”) concrete pad if stand-alone, at the same height as other panels if part of an existing suite or MCC installation.

C. Locate and install controllers and panels so as to be easily accessible for maintenance and readability of displays.

D. Displays and keyboards are to be protected during the construction and commissioning period but remain readily accessible on the panel's exterior.

E. When drilling conduit entry points in panels, protect internally mounted equipment from vibration, shock or metal filings. Panels and conduit installations made to them must maintain their appropriate EEMAC rating. Confirm panel location with Engineer/Client prior to fixing.

F. Following Site Acceptance, provide to the Engineer a minimum of six identified control panel keys for each panel.

G. Organize I/O points in racks so that I/O from two or more pieces of equipment with the same process function are divided among at least two groups of I/O cards in a rack. Organize the I/O points so that if one I/O card fails, at least one piece of equipment from the group that has the same process function will be fully operational.

H. Wire all spare I/O to terminal strips and terminate according to the Manufacturer's recommendations.

I. If single ended analog signal modules are used, group signals in such a way that signals of the same power supply are connected to one card. Otherwise, use signal isolators.

J. Follow the Manufacturer's recommendations for loading resistors on digital outputs to limit the affect of leakage currents through triac and relay outputs.

K. Follow the Manufacturer's recommendations for surge suppression on inductive loads.

L. Once ICPs are installed and sufficient field wiring is in place to power up the PLCs, immediately install keepers on any lighting panel or MCC circuit breaker feeding the ICP. Unless otherwise authorized by the Engineer, the ICP and PLC are to remain powered up at all times.

M. Once PLCs are installed at site and sufficient field wiring is in place to begin commissioning software, take the necessary steps to prevent hardware failure or unauthorized tampering with running control programs. Ensure ICPs and PLCs are not inadvertently switched off or crashed by unsanctioned activity.

3.7 SYSTEM WIRING REQUIREMENTS

A. Provide all required system wiring. All wiring shall conform to the latest revision of the OESC and to the Electrical Area Classification for Hazardous Locations where applicable.

B. Where specific wiring types are not specified (except AC power wiring) provide types of wiring as recommended by the System Component Manufacturers.

C. Provide conduit for all system wiring, except for power cords with integral plugs, and except where duct, tray or similar raceway are indicated, in accordance with Section 16050. Unless otherwise specified, conduit and wiring requirements specified in Section 16050 apply to the work of this Section.

D. Unless otherwise specified, install analog signal cabling, including transducer cables and network cables in separate dedicated rigid steel conduits away from AC power and other EMF sources. Ultrasonic sensor cabling must be installed strictly in accordance with Manufacturer's instructions.

E. Seal all conduit terminations to prevent moisture penetration.

F. Communication and analog signal conductor shields must be isolated and taped back at one end and terminated at a single ground point at the other as shown on the Loop Drawings. If the correct grounding information is unclear, confirm exact shield termination and isolation details with the Equipment Manufacturer and the Engineer.

G. Using suitable permanent wire markers and terminal block tags, number all ICP terminal blocks as indicated on the Electrical Drawings.

H. Install lightning and surge protection on all analog signal cabling entering or exiting buildings. Provide two (2) spare units.

I. Install signal isolators (24VDC externally powered if not loop-powered devices) on all analog loops with signal cabling running outside buildings, speed control signals into variable frequency drives, and any situation where potential EMF could damage electronic equipment. Provide two (2) spare isolators.

J. Unless specifically shown otherwise, all digital alarm contacts shall be "Normal Open".

K. Use only manufacturer molded cable assemblies between computer and peripherals, such as printers, RS-232, Ethernet, etc. Unless otherwise approved by the Engineer, do not supply custom-made cables. Where custom cables are allowed, connectors must be complete with proper shells and able to withstand physical bending and twisting.

3.8 IDENTIFICATION AND TAGGING

A. Identify systems and equipment in accordance with the provisions of this specification. Systems and equipment include:

1. All items furnished under this Contract.

2. Existing items defined in this Contract that require new identification.

B. Identification of wiring and electrical equipment is specified in Appendix 1-1 – Process Equipment List and Appendix 1-3 – Device Control Wiring List. Refer to Appendix 1-4 – System Tagging.

C. Provide a Tag text list to Engineer for approval prior manufacturing.

D. Tags:

1. Provide tags of the following materials:

   a. Field instrument tags are 10 gauge, stainless steel with Black lettering.

   b. Equipment tags are 10 gauge, stainless steel with Green lettering.

   c. Control panels tags are to be Lamicoid, black background with white lettering.

2. Size tags as 100 x 40 (4" x 1 ½"), with max 3 lines, font height as 6.5 mm.

3. Use text with the following characteristics:

   a. Lettering – Uppercase.

b. Font – Times New Roman.

c. Style – Regular.

d. Size – Maximum to fit label width, minimum 3 mm.

e. Character spacing – Normal.

f. Justification – Center lettering on each line.

E. Submit with the Shop Drawings, a typed list indicating all nameplates wording as well as proposed types, sizes and styles.

F. Prior to installation of new items, apply identification nameplates to each instrument, panel, telemetry device and controller. Where existing instruments are re-used or connected into the new system/control panel(s), provide identification nameplates for these instruments also.

G. Use the Client tag identifier and designated service and with the approved wording submitted in Shop Drawings. Instrument tag names conform to the I/O list, device list, and to the P&ID issued. Refer to the Appendix 1-1 – Device Wiring List for the correct tag prefixes, loop numbers and service descriptions.

H. Lamacoid nameplates shall be provided for each piece of instrumentation equipment. (For interior or exterior panel mounted equipment).

I. Mount tags so that they are readily apparent and legible. Place tags within a height range of 1200 mm to 1650 mm (4 to 5 ½ feet) if possible. Do not obscure or mount over other nameplates, labels or tags.

J. Nameplates shall be fastened with corrosion resistant screws.

K. Nameplates on field equipment and external to control panels to be black background with white lettering. Internal panel labels to be black background and white lettering.

L. Identify transducers and miscellaneous hardware with stainless steel labels denoting tag name only, permanently fastened to either the transducer housing or cable.

M. Wiring:

1. Identify all PLC I/O signals on field terminal rails with appropriate tag.

2. Identify all wiring at both ends with appropriate, permanent wire markers.

3.9 MODIFICATIONS TO EXISTING EQUIPMENT

A. The Specifications and Drawings have been developed on a conceptual basis. Provide all hardware, wiring etc. to connect the instrumentation added, moved or modified under this and other divisions for a complete, and operating system. Verify the actual site conditions and modify the proposals to affect the desired result without additional charge to the Contract.

B. During the tendering period, visit the site and ascertain the actual conditions and the extent of the work, particularly in the following area:

1. Removal of obsolete.

C. Do not remove existing equipment from service without written approval from Client.

D. Removal of equipment and/or wiring means the disconnection and complete removal of related cables, conduit and wiring from the equipment, shut off related power sources and capping resulting holes or openings, blanking off any panel openings, etc. Provide tags at the power sources indicating “Not Used”.

E. Leave in place existing wiring and equipment not required to be modified, whether or not it meets current codes unless, there is a definite safety hazard. Draw to the attention of the Engineer any such condition.

F. Equipment taken out of service shall be removed and delivered to the Client or left in place as directed by the Engineer.

3.10 INSTRUMENTATION & CONTROLS FIELD PRE-COMMISSIONING

A. Comply with the requirement of Section 01800.

B. All field testing, calibration procedures, commissioning procedures, etc., shall be approved by the Engineer.

C. Supply all materials, equipment and labor necessary for testing, calibration, commissioning and repair and be prepared to present proof of recent calibration on testing equipments.

D. For Control Loop Checkout/Verification, arrange for the Contractor, Electrical, Instrumentation and Control Subcontractors to test loop wiring between PLC and field devices, advise the Engineer to be present for the procedure.

E. When testing instrumentation loops, perform the testing of each loop in sequence and in groups. The testing of instrument loops will be graded on a pass/fail basis. If more than two instrument loops within a group fail the loop checkout, the entire group of loops will be deemed to have failed the checkout. When the failed loops have been repaired, the entire group must be retested.

F. Prepare Instrument Calibration Forms for every field instrument and Loop Check Sheets for every control loop.

G. Prior to installation of application programs for automatic control by others, all installations must be proved correct and fully operational as outlined below.

H. After the instrumentation and control system has been initially visually inspected for proper installation, including any specified vendor inspection, but prior to any introduction of process fluids/materials to the facility (if retrofit on existing process, submit proposed testing method), energize the system loop by loop and:

1. Check and test the operation of each and every system component and adjust or repair as necessary.

2. Confirm all instrument calibration parameters, i.e., 4-20mA span and displayed ranges, with the Engineer.

3. Check the calibration of each instrument, and where necessary, re-calibrate in accordance with the Manufacturer's instructions.

4. Ensure that calibration and commissioning work is carried out by qualified technicians, and have the work performed by the Manufacturer’s Service Representatives if so specified.

5. Prepare typewritten record on each Instrument Calibration Form of the calibration, repair or replacement work performed and submit to the Engineer. Enter the calibration information and any other relevant details about each instrument on the Product Data Sheets as per Section 1.0 of this Specification.

6. Loop check all field signal wiring for continuity and correct contact polarity. Ringing wires from terminal strips is insufficient. Check each loop by interrogating the controller I/O via on-line utilities and exercising field equipment to confirm correct field operation. Field actions include power-up instruments, set-up calibration, energize MCC starters (disabling power feeds as appropriate) testing hand-off-auto switches, tripping field pressure, float and level switches, etc.

7. Do <u>not</u> perform insulation tests or “megger” tests on any instrument wiring connected to field or panel equipment.

8. When the inspection, testing, and calibration is complete, submit Instrument Calibration Forms, Loop Check Sheets and Product Data Sheets and advise the Engineer in writing that all equipment has been checked and is ready for introduction of process fluids or material.

I. Once process fluid or material have been introduced to the facility, or part of process:

1. Repeat the above checks to confirm that the equipment operates correctly when actuated by actual process fluid or material: e.g., that high level alarm float switches are actuated at the correct height by a rising fluid, and low-level switches operate correctly on a falling fluid level.

2. Repeat the above checks to confirm that the equipment operates correctly when actuated by actual process fluid or material: e.g., that high level alarm float switches are actuated at the correct height by a rising fluid, and low level switches operate correctly on a falling fluid level.

3. Forward to the Engineer a letter certifying that the instrumentation and control system is complete, operational, and ready for site acceptance, and ready to load Control Program.

4. Each and every Instrument calibration, Final Loop Check and equipment operation checks will be witnessed by the Engineer. Upon satisfactory demonstration of instrument and/or loop operation, the Engineer will sign off the Product Data Sheets, Calibration Forms and Control Loop Check Sheets. The instrumentation and control system will then be considered ready for testing control software, and finally Site Acceptance Testing.

5. Instruments, loops and equipment which are found to be inoperable or improperly calibrated, will immediately be rejected. The associated equipment must be rectified, re-calibrated and sheets revised and resubmitted as soon as the problem is resolved.

6. If three or more such instances occur, the Contractor will be requested to repeat all pre-commissioning checks.

7. When all equipment, instruments and systems have been demonstrated and Product Data Sheets, Instrument Calibration Forms and Loop Check Sheets have all been signed off, forward a complete set of the signed sheets to the Engineer.

3.11 CONTROLLER APPLICATION PROGRAM INSTALLATION, TESTING & CONTROL SYSTEM COMMISSIONING

A. When field pre-commissioning of the instrumentation and control system has been completed as specified above, inform the Engineer that the system is ready to load Control Application Program.

B. Allow six weeks for the presence of qualified Instrument Technicians and component Manufacturer's Representatives to assist Engineer in testing of the Control Application Program.

C. Coordinate all commissioning activities with Contract Administrator required. Supply all labor and materials required to coordinate instrument and controls commissioning with other Trades.

D. Provide all labour and materials necessary to commission and operate the system for the ten day wet test and the 14 day sewage test. During this time all equipment is expected to run in automatic mode.

E. Perform the commissioning activities associated with operation of the plant under control by the Software Program, as directed by the Programmer.

F. Take all necessary steps to ensure that all equipment or parts of the system successfully tested and deemed ready for their intended use stay in operation.

G. Provide clear signs/marking as to required status on the equipment that is to remain powered up, left in Auto, or remain Off, etc., during the commissioning period. Agree with the Engineer/Client on the method for achieving this and ensure safe and compliant operation of the facility and equipment at all times.

H. Adopt a recognized lock-out policy and agree to it with the Engineer. Coordinate the requirement for lock-out for safety reasons with the scheduled Commissioning Program so that all equipment needed to commission a process/area is available concurrently.

I. Make minor corrections/additions to wiring, terminations, instrument calibrations and settings as normally expected necessary to resolve operational problems during commissioning at no additional cost.

3.12 SITE ACCEPTANCE TESTING (SAT)

A. When initial site inspections and commissioning of the instrumentation and the control system is satisfactorily complete, schedule with the Contract Administrator/Client to demonstrate the entire system is ready for to start Control Application Program commissioning.

B. Prepare and submit an itemized SAT Test Plan for approval by the Engineer a minimum of ten (10) working days in advance.

C. SAT must be finished not later than 40 working days before start-up.

D. Include for the presence of qualified Instrument Technician and Equipment Manufacturers' Representatives to supervise the test if requested by the Engineer. Testing is to demonstrate the proper operation of all field physical input and output signals of the PLC system under actual operating conditions to the satisfaction of the Engineer. This includes proper operations and communications between PLCs, and all peripheral devices. Supply all labor, instruments and materials to perform the testing.

E. The SAT must be satisfactorily completed prior to applying for a Certificate of Substantial Performance.

F. Deliver all testing software, panel keys, etc., to the Contract Administrator.

G. Deliver final version of PLC Programs in CD format after receiving Certificate of Substantial Performance to the Engineer/Client.

3.13 TRAINING

A. Comply with the requirement of Section 01800.

B. Supply a Site Training Program for the Plant Operating personnel consisting of:

1. Maintenance Training (16 hours) in two (2) groups of eight (8) hours each by Instrument Supplier and/or appropriate Equipment Manufacturer's Representatives.

2. Operator training (16 hours) in two (2) groups of eight (8) hours each by Instrument Supplier.

C. Dates and personnel receiving training will be coordinated by the Client.

D. The Training Program is to be conducted by qualified Instrument Technicians and competent Manufacturer's personnel experienced both with the product and with instruction, using system Operation and Maintenance Manual data as the basis for demonstrations and instructions.

E. Training shall take place at the site or at the equipment itself. Operation and Maintenance Manuals shall be submitted to the Client a minimum of 30 days prior to the training occurring for use in the training course.

F. The Training Program is to include routine maintenance of the equipment.

G. The Site Training Program must be complete prior to application for a Certificate of Substantial Performance of the work.

H. Pay all cost associated with the Training Program, with the sole exception of salaries associated with the operating personnel being trained.

I. Submit a course outline to the Engineer for approval 30 days prior to the start of the course. The Engineer reserves the right to modify the course content.

3.14 PROCESS PERFORMANCE OPERATION

A. Provide all labor and materials necessary to support the process and the instrumentation and control system for the duration of the Contract Performance Run. During this operation all equipment is expected to run in automatic mode.

3.15 SYSTEM INTEGRATOR

A. Use only the following pre-approved system integrators for supply of the Water Treatment Plant and Intake Pumphouse instrument control panels, related PLC hardware and programming:

1. Nor-Tech Power & Controls
   2691 White Street
   Val Caron, ON P3N 1B2
   Telephone: (705) 897-8889

2. IONIC Engineering
   95 Mumford Road
   Lively, ON P3Y 1L1
   Telephone: (705) 692-0101

B. The City of Greater Sudbury's SCADA Specialists will serve as the SCADA Integrator. The system integrator shall coordinate the conception, development, and completion of the required SCADA work with the SCADA screen developer.

3.16 WARRANTY AND GUARANTEE PERIOD ACTIVITIES

A. During the warranty period, hardware service should be provided by a Factory Trained Service Representative who shall be on-site within 24 hours of a service request, seven (7) days/week, including weekends and holidays. The Service Representative shall be equipped with all necessary tools, testing equipment, spare parts, and expertise to perform the service in one visit.

1. For each service call submit a report giving the following information:

   a. Part numbers, description and prices for items replaced.

   b. Revised hard copy/soft copy listings of program changes.

   c. Hours worked by maintenance personnel.

   d. Reason for the service call, and whether preventative, unscheduled or corrective maintenance was carried out.

   e. Name of Client technician present during repairs. Explain the problem and solutions to the Client technician(s).

   f. Description of problem as discovered on arrival at site and itemized report of activities performed to isolate and correct problem.

   g. Identification of any required actions to prevent similar future occurrence.

   h. Name of attending operations representative, time of call and time of arrival on site.

B. A single contact point shall be provided for all hardware such that the Client Representative need only call a single phone number irrespective of which piece of hardware has failed.

C. Provide spare components/firmware and software upgrades as follows:

1. The Supplier should have access to a dedicated spare parts inventory for each component provided. Parts shall be available within 24 hours of a service parts request, seven (7) days/week.

2. Include key spare parts that are not normally available immediately from stock, in the Recommended Spare Parts List.

END OF SECTION

LIST OF APPENDICES

APPENDIX 1-1: PROCESS EQUIPMENT LIST
APPENDIX 1-2: PRODUCT DATA SHEETS
APPENDIX 1-3: DEVICE CONTROL WIRING LIST
APPENDIX 1-4: SYSTEM TAGGING
APPENDIX 2-1: PROCESS CONTROL NARRATIVE
APPENDIX 4-1: INSTRUMENT CHECK AND SIGN-OFF SHEETS

APPENDIX 1-1
PROCESS EQUIPMENT LIST

P&ID	Tag	Description		Location	Physical Location	Remarks
N002	RSP-3100	Pump 1	New Pump, New VFD	Lift Station	Wet Well/Outdoors	
N002	RSP-3110	Pump 2	New Pump, New VFD	Lift Station	Wet Well/Outdoors	
N002	LSHH-3211	Wet Well High High Level	New Float Switch	Lift Station	Wet Well	
N002	LSHH-3221	Wet Well High High Level	New Float Switch	Lift Station	Wet Well	
N002	LIT-3221	Well Level Indication	New Water Pilot Level Transmitter	Lift Station	ICP-3000	
N002	LIT-3211	Well Level Indication	New Ultrasonic Level Transmitter, model Siemens Milltronics 200	Lift Station	ICP-3000	
N002	PIT-3401	Discharge Pressure Indication	New Pressure Transmitter, [0-1000kPa]	Lift Station	Wet Well	
N002	FIT-3401	Discharge Flow Indication	New Flowmeter, [0- L/s]	Lift Station	Wet Well	
N002	LSH-3401	Sump Pump High Level	New Float Switch	Lift Station	Wet Well	
N002	LSHH-3401	Valve Chamber High High - Flood Level	New Float Switch	Lift Station	Wet Well	
N003	GEN-3950	Generator	New Genset	Lift Station	Outdoors	
N003	ATS-3901	Automatic Transfer Switch	New ATS	Lift Station	Outdoors	

APPENDIX 1-2
PRODUCT DATA SHEETS

Level - Ultrasonic Transmitter

Tag No:	**DON-LS-LIT-3211**		
Location:	Wet Well		
Service:	Wet Well Level		
Vessel/line No.:			
Process:			
Fluid:	Raw Sewage		
Temp min/max:	0 - 35 Deg C		
Level min/max:	0 - 10m		
Sensor:			
Type:	Ultrasonic		
Remote Element:	Yes		
Signal Cable:	Cable length to fit application		
Blanking:	300 mm (12")		
Mounting:	See Notes		
Housing:	Hermetically Sealed in Kynar		
Temp. Comp.:	Built In		
Submersible:	Submergence Shield Kit		
Options:	Channel Bracket, Wall Mount		
Transmitter:			
Output:	4 - 20 mA isolated (600 Ω)		
Power Supply:	115 – 230 Vac, 50/60 Hz		
Enclosure:	Remote, Wall Mounted, NEMA 4		
Indication:	Local Back Lit LCD, Eng units		
Calibr. Range O/P 1:	0 - 100% (Field To Confirm in Meters)		
Calibr. Range O/P 2:			
Accuracy	.25% of range or 6mm (¼")		
Output Relays:	6 x Relay, SPDT		
Communications:			
Options:	Handheld Programmer		
Electrical:			
Approval:	CE, FM, CSA, UL_C Listed		
Notes:	1) Refer to manufacturer's recommendations for installation. 2) Position transducers for optimum aiming, free of obstructions, accessible and so that they are above the water level by at least the blanking value. 3) Supply relay programmed for LOE/Fail. Fail to "Empty mA output". 4) Supply additional spare parts as noted.		
Manufacturer:	**1st Named:**		
Manufacturer:	Siemens		
Model Number:	Multi-Ranger 200, Sensor: XPS-10 Echomax		
	Named Alternate:		
Manufacturer:	Endress + Hauser		
Model Number:	FMU-90		
Installation:			
Serial No.:			
Calibration:	Provide ISO Certified		
Zero/Low:	Calibration Certificate		
Span/High:	With Shop Drawings		
Verification:			
Date:			
Signature:			

	Level - Hydrostatic Pressure Transmitter		
Tag No:	**DON-LS-LIT-3221**		
Location:	Wet Well		
Service:	Wet Well Level		
Vessel/line No.:			
Process:			
Fluid:	Raw Sewage		
Temp min/max:	0 - 35 Deg C		
Level min/max:	0 - 10m		
Sensor:			
Type:	Hydrostatic Pressure Sensor		
Remote Element:	S. S. Diaphragm / Ceramic		
Body Material:	316 S.S.		
Signal Cable:	Cable length to fit application		
Mounting:	See Notes		
nsor Outer Diameter:	22mm (0.87inch)		
ermination Enclosure:	NEMA 4X		
Transmitter:			
Type:	Smart with HART Protocol		
Output:	4 - 20 mA isolated (600 □)		
Power Supply:	24 Vdc 2 Wire Loop		
Indication:	Local LCD display in Eng. Units		
Calibr. Range :	Factory Calibrated to 0-30m H2O		
Accuracy	±0.2 % of Calibrated Range		
Output Relays:	3 x Relay, SPDT		
Options:	Provide Mounting Clamp and		
	Termination Box (NEMA 4X)		
Electrical:			
Approval:	CE, FM, CSA, UL_C Listed		
Notes:	1) Refer to manufacturer's recommendations for installation. 2) Install probe at a point free from flow and turbulence, or use a guide tube, internal diameter of guide tube shall be a minimum of 1mm larger then the outer diameter of the selected probe 3) Probe cable to be terminated in a suitable terminal box, the terminal box must provide optimum humidity and climatic protection, shall be suitable for outdoor installation		
Manufacturer:	**1st Named:**		
Manufacturer:	Endress + Hauser		
Model Number:	Sensor: Waterpilot FMX21, RIA-46 Loop-powered process meter		
	Named Alternate:		
Manufacturer:	General Electric Company (Druck)		
Model Number:	Model: PTX1230, RIA-46 Loop-powered process meter		
Installation:			
Serial No.:			
Calibration:	Provide ISO Certified		
Zero/Low:	Calibration Certificate		
Span/High:	With Shop Drawings		
Verification:			
Date:			
Signature:			

	Level Float Switch		
Tag No:	**DON-LS-LSHH-3211**	**DON-LS-LSHH-3221**	
Location:	Wet Well	Wet Well	
Service:	High High level Alarm	High High level Alarm	
Vessel/line No.:			
Process:			
Fluid:	Raw Sewage	Raw Sewage	
Temp min/max:	0 - 25 Deg C	0 - 25 Deg C	
Press min/max:	ambient	ambient	
Tank Material:	Concrete	Concrete	
Tank Depth:			
Specific Gravity:			
Switch:			
Type:	Mercury Free Dry Contact NO/NC	Mercury Free Dry Contact NO/NC	
Contact Form:	SPDT Form C	SPDT Form C	
Rating:	10 Amp @ 250 Vac	10 Amp @ 250 Vac	
Differential:	100 mm (4 ")	100 mm (4 ")	
Switch Action:	Switch Opens On High Level	Switch Opens On High Level	
Case:			
Material:	Polypropylene	Polypropylene	
Cable Length:	6m Potted at Float (Note 3)	6m Potted at Float (Note 3)	
Accessories:			
Sway Control Rings:	Yes	Yes	
Hanger Bracket:	Yes	Yes	
Local Jct Box:	Yes	Yes	
Interposing Relay:	Yes	Yes	
Power Req'd:	No	No	
Electrical:			
Approval:	CSA	CSA	
Enclosure:	Nema 4x	Nema 4x	
Class/Div/Group:	Class I Division 1 Group C & D	Class I Division 1 Group C & D	
Notes:	1) Mount sway control rings and hanger brackets using cinch anchors. 2) Supply Mercury free contacts . 3) Do not splice the cable between the float and the local junction box. 4) NSF certification shall be provided for drinking water applications		
Manufacturer:	**1st Named**		
Manufacturer:	Xylem ITT		
Model Number:	ENM - 10		
	Named Alternate:		
Manufacturer:	APG		
Model	FT-100		
Installation:			
Serial No.:			
Calibration:			
Zero/Low:			
Span/High:			
Verification:			
Date:			
Signature:			

Tag No:	**DON-LS-LSH-3401**	**DON-LS-LSHH-33401**	
Location:	Sump Pump	Valve Chamber	
Service:	High High level Alarm	High High - Flood level Alarm	
Vessel/line No.:			
Process:			
Fluid:	Raw Sewage	Raw Sewage	
Temp min/max:	0 - 25 Deg C	0 - 25 Deg C	
Press min/max:	ambient	ambient	
Tank Material:	Concrete	Concrete	
Tank Depth:			
Specific Gravity:			
Switch:			
Type:	Mercury Free Dry Contact NO/NC	Mercury Free Dry Contact NO/NC	
Contact Form:	SPDT Form C	SPDT Form C	
Rating:	10 Amp @ 250 Vac	10 Amp @ 250 Vac	
Differential:	100 mm (4 ")	100 mm (4 ")	
Switch Action:	Switch Opens On High Level	Switch Opens On High Level	
Case:			
Material:	Polypropylene	Polypropylene	
Cable Length:	6m Potted at Float (Note 3)	6m Potted at Float (Note 3)	
Accessories:			
Sway Control Rings:	Yes	Yes	
Hanger Bracket:	Yes	Yes	
Local Jct Box:	Yes	Yes	
Interposing Relay:	Yes	Yes	
Power Req'd:	No	No	
Electrical:			
Approval:	CSA	CSA	
Enclosure:	Nema 4x	Nema 4x	
Class/Div/Group:	Class I Division 1 Group C & D	Class I Division 1 Group C & D	
Notes:	1) Mount sway control rings and hanger brackets using cinch anchors. 2) Supply Mercury free contacts . 3) Do not splice the cable between the float and the local junction box. 4) NSF certification shall be provided for drinking water applications		
Manufacturer:	**1st Named**		
Manufacturer:	Xylem ITT		
Model Number:	ENM - 10		
	Named Alternate:		
Manufacturer:	APG		
Model	FT-100		
Installation:			
Serial No.:			
Calibration:			
Zero/Low:			
Span/High:			
Verification:			
Date:			
Signature:			

Magnetic Flow Meter

Tag No:	**DON-LS-FIT-3401**		
Location:	Lift Station Discharge		
Service:	Discharge flow		
Vessel/line :	200 mm (8")		
Process:			
Fluid:	Raw Sewage		
Velocity min/max:	0 - 1.7 m/sec		
Temp min/max:	0 - 25 Deg C		
Press min/max:	0 - 300 kPa		
Flow min/max:	0 - 300 L/s		
Up/Down Stream:	5/2 Min.		
Flow Tube:			
Line Size:	400mm C.S.		
Coil Excitation:	Pulsed D.C.		
Body Material:	304 SS with protective coating		
End Conn.:	Flanged, ANSI B16.5: Class 150,epoxy coated		
Liner Material:	NBR Hard Rubber		
Electrode Material:	Alloy C-22 Bullet Nose		
Lining Protection:	Yes		
Grounding:	See Notes		
U.S. Cleaning:	No		
Empty Pipe Detect:	Yes		
Housing:	NEMA 6P(IP 68) Occasional Submersion		
Transmitter:			
Enclosure:	Remote Wall Mounted, NEMA 4		
Power Supply:	115 – 230 Vac, 50/60 Hz		
Sensor Cable:	Coil and signal cable length to fit application		
Analogue Output:	4 - 20 mA isolated (600 Ω)		
Pulse Output:	1 Pulse / Cubic Meter		
Communications:	Using HART handheld or equivalent		
Accuracy:	± ½% of Rate		
Indication:	Local LCD, Eng units (l/s)		
Options:	LCD indication of both:		
	flow (L/s), totalized flow (m^3)		
Electrical:			
Approval:	CSA		
Class/Div/Group:	General purpose		
Notes:	1) All Magnetic Flow Meters on this project must be from the same manufacturer.		
	2) Follow all manufacturer's installation recommendations.		
	3) Ground the sensor flowmeter in accordance with manufacturers instructions.		
	4) Provide hardware required to mount flow sensor and transmitter, as required.		
	5) NSF certification shall be provided for drinking water applications		
	6) Supply additional spare parts as noted.		
Manufacturer:	**1st Named:**		
Manufacturer:	Endress & Hauser		
Model	ProMag W500 (including calibrator)		
	Named Alternate:		
Manufacturer:	Krohne		
Model	Optiflux 2000, IFC300		
Installation:			
Serial No.:			
Calibration:	Provide ISO Certified		
Zero/Low:	Calibration Sheet		
Span/High:			
Verification:			
Date:			
Signature:			

Pressure Transmitter

Tag No:	**DON-LS-PIT-3401**		
Location:	Lift Station Discharge		
Service:	Discharge Pressure		
Vessel/line No.:			
Process:			
Fluid:	Raw Sewage		
Temp min/max:	0 - 25 Deg C		
Press min/max:	0 to 250 PSI (1723kPa)		
Element:			
Type:	Pressure		
Diaphram Material:	316 S.S.		
Wetted Parts	316 S.S.		
Body Material:	316 S.S.		
Fill Fluid:	Silicon Oil		
ax./Min. Overpressure:	2000 p.s.i. / 0 p.s.i.		
End Conn.:	13 mm (½")		
3-Valve Manifold:	Yes / 316 S.S.		
Transmitter:			
Type:	Smart with HART Protocol		
Output:	4 - 20 mA isolated (600 Ω)		
Power Supply:	24 VDC Loop-Powered		
Enclosure:	Watertight enclosure meets NEMA 4X/IP66		
	requirements, with window (Digital LCD display)		
Indication/Units:	Local / kPa		
Calibr. Range:	0 to 250 kPa		
Accuracy:	± 0.1% of Span		
Calibration:	HART Communicator - See Spec.		
Options:	Mounting Bracket for Wall/Pipe		
Electrical:			
Approval:	CSA		
Enclosure:	NEMA 4		
Electrical Conn.	3/4" NPT		
Class/Div/Grp:	General Purpose		
Notes:	1) Provide mounting hardware including pipe stand.		
	2) All manufactures recommendations for installation must be followed.		
	3) Tap on side of process piping for liquid service, and tap on top for gas service.		
	4) Wetted parts: As required by the process, 316 SS minimum NSF certified drinking water system components shall be used for all potable water applications		
	5) Supply additional spare parts as noted.		
Manufacturer:	**1st Named:**		
Manufacturer:	Rosemount		
Model Number:	3051		
	Named Alternate:		
Manufacturer:	Endress + Hauser		
Model Number:			
Installation:			
Serial No.:			
Calibration:	Provide ISO Certified		
Zero/Low:	Calibration Certificate		
Span/High:			
Verification:			
Date:			
Signature:			

	Instrument Control Panel - ICP Page 1 of 3
	DON-LS-ICP-3000
General:	Supply one (1) CSA approved, instrument control panel to house the PLC Racks and associated components and instruments, generally as follows: NEMA 4X for outdoor areas.
Finish:	Fabricate of high grade cold rolled steel (14 gauge), phosphatize, prime, and paint with with ANSI 61 Light Grey baked enamel inside and outside. Subpanels to be on 12 gauge CRS finished with white baked-enamel. The panel shall have minimum three sections of each 36" wide. Section I shall have one PLC rack and section II shall have other components and I.S barriers, where required. Terminal strips shall be suitably grouped between all sections
Equipment:	Provide the following as minimum: Provide all PLC racks and I/O modules; interior backplane for mounting hardware and components, Provide an interior light c/w door switch. ("Omron" m/n 2-15GW2-B-7K) Provide all signal isolators as required. Provide one spare. ("Entrelec" "Phoenix" or equal) Provide all one-to-one isolating relays as required. Provide two spare. ("Omron" G2R-1-SN c/w P2RF-05-E Base) Provide all data line surge suppression as required. ("Entrelec" "Phoenix" or equal) Provide breakers, Terminals, wireways etc. as required Provide UPS external maintenance bypass switch and mount it inside the ICP on the back plane All spare IO points are to be wired to outgoing terminal blocks. Panel fabricator to provide the Fibre Enclosure in the PLC panel as per spec sheet included in the contract document and mount it on the side wall of the panel. This enclosure provides loop storage for distribution cable.
Terminal Blocks:	Provide European DIN style terminal blocks.("Entrelec", "Phoenix" or equal) All terminal blocks and IO terminals shall be uniquely identified and permanently marked. Provide individual terminal block type mini-circuit breakers to isolate field devices powered from the panel. Reserve one side of each terminal strip for field incoming conductors. Do not make common connections and jumpers required for internal wiring on the field side of the terminal. Provide jumper bars (not wires) to connect common wires and terminals. Provide "knife switch" type terminal blocks on all analogue 4-20 ma loops to connect an ammeter in series or to electrically isolate the loop. Provide end plates, partition plates and end stoppers where required Provide fused terminal blocks c/w neon "fuse blown" indicator on a knife switch for all digital loops. Fuse instrument loops individually and supply spare fuses. Provide 250 Ω precision resistor at terminal blocks where required. Use only thermocouple terminals and thermocouple wires for thermocouple loops Provide 20% spare mini circuit breakers (MCB) power circuits (5 minimum)
Doors:	Supply neoprene gasketed doors with a continuous S.S. piano hinge with removable pin and a ground strap. Brace front access door to ensure rigidity in the open position. All wiring to instruments mounted on doors shall be twisted into one bundle and shall cross from the cabinet to the door at a shallow angle using expandable sleeving. Provide door with lockable, recessed door handles c/w six sets of keys. All door mounted equipment shall be designed for flush mounting and shall be properly sealed to retain the panel's EEMAC rating. Provide Lamacoid Nametag for all panel door mounted components For door mounted instruments refer to panel layout drawing

Instrument Control Panel - ICP

Page 2 of 3

Power Distribution:

Provide a 10A 120 VAC duplex receptacle hardwired to its own fused circuit.
Provide a 15A 120 V AC 6 socket powerbar (Tripp Lite Isotel 6 Ultra) c/w power and telephone surge suppression hardwired to it's own fused circuit and powered from the UPS. Tag "UPS Power"
Provide two (2) 120 Vac/24 Vdc (2 Amp Min.) power supplies c/w redundant power supply switching module (Entrelec) or power distributor block (Phoenix) as required. Size so that one power supply can handle the total 24Vdc load. ("Entrelec" "Phoenix" or equal)
Provide wiring to UPS maintenance bypass switch as per UPS manufacturer's wiring diagram
Provide 24 V DC power supply wiring to Network switch
Refer to instrumentation power wiring diagram for power distribution

Wiring:

Physically separate power supply cables from analogue signals and communication cables using plastic wireways, minimum 4" wide x 3" deep for incoming field wiring, and suitable size for internal wiring.
Segregate signal wiring from control power wiring according to the following categories: 120 Vac, 24 Vdc analogue, 24 Vdc digital, communication wiring.
Provide Velcro tie wraps (Hubbell or Panduit) for bundling and securing all wiring not enclosed in duct.
Internal wiring not less than 16 AWG 300V single conductor stranded copper with TEW insulation.
Provide Belden type 1118A, #16 shielded twisted pair for analogue signals.

For 120 Vac power wiring provide 12 AWG with insulation rated at 600V.
Communication cables to be 4 pair, 18 AWG stranded copper, each pair separately twisted.
Identify all wiring with heat shrinkable slip-on markers c/w type written tag numbers.
Terminate field wiring at terminal blocks with no more than one wires on each side of the block.
Terminate all I/O points, including spare at the terminal blocks within the cabinet.
Tag all equipment and wire ways inside the panel with Thermal Printed Metalized Tape
Provide interconnection cabling of all Ethernet devices internal to the PLC panel. CAT5E patch cables are to be factory made, ruggedized with a protective connector boot.
Provide CAT6 wiring to front door mounted Ethernet RJ-45 outlet (Computer Interface). CAT6 wiring shall be done from the PLC Ethernet port or switch. Cable length as required
All wiring to be done in shop

Color of Insulation:

Colour code wiring as follows:

1) Line and load circuits AC power - 1 phase	: Black-White(120V)/(240V)
2) AC control circuits	: Orange
3) DC control circuits	: Red (+), Black (-)
4) Current carrying neutral conductor	: White
5) DC signal grounding conductors	: Green/White Stripes
6) Equipment grounding conductors	: Green
7) Foreign source interlock control circuits	: Yellow
8) Intrinsically safe circuits	: Light Blue

Grounding:

Ground the power system and controller chassis in accordance with the manufacturer's recommendations.
Provide grounding bus bar c/w ground screws.
Provide vinyl insulated ring type crimp connectors for all ground connections.
Provide 2 ground buses, one for shield and cabinet grounding, and one for signal grounding.
Ground conductors are to be #6 AWG, coloured green with white stripes used for instrument grounds and dark green for control circuit ground.

	Instrument Control Panel - ICP Page 3 of 3		
Panel Sizing:	Provide 20% back panel space for additional components Provide 20% spare power circuits with MCBs wired to terminals. Provide minimum of 20% spare terminals (no wires terminated) and 20% space for spare terminal on the DIN rail Provide space for additional PLC rack Provide 20% spare IO points on the installed card Provide space allowance for a cable marshalling space next/below the network switch. Provide space allowance for a small fibre breakout box/enclosure. (28H x 33W x 14D cm). Mount the UPS inside/outside the ICP as per UPS datasheet		
General Notes:	The panel fabricator shall configure the switch operating system to provide fully functional operation of the package/system. This allows commissioning of the package/system independently of the client's Ethernet network implementation schedule.		
Equipment:	**Intrinsically safe barriers and wiring, where applicable:** I.S. barriers shall be mounted on a separate terminal at the bottom or top end of the panel according to the cable entry. No other components shall be installed on the I.S terminal strip Provide separate panduit for I.S wiring Intrinsically safe conduits shall be grouped together and the cable entry point shall be near to the I.S terminal strip Leave space for minimum of 100% spare barriers.		
Wiring:	Separate intrinsically safe wiring from non-intrinsically safe wiring using one of the following methods: 1) raceway or conduit 2) grounded metal or insulated partition between the intrinsically safe and non-intrinsically safe wiring. 3) air space of at least 50 mm (2 inches) between the intrinsically safe and non-intrinsically safe wiring and the wires must be tie wrapped down to prevent loosening and shorting together. Identify intrinsically safe wiring using a light blue colour code. Physically separate digital signals from analogue signals . Provide tie wraps for bundling and securing all wiring. Internal wiring not less than 16 AWG 300V single conductor stranded copper with TEW insulation. Identify all wiring with heat shrinkable slip-on markers c/w type written tag numbers. Do not use terminal blocks. Ground intrinsically safe system in accordance with I.S.barrier manufacturer's recommendations Provide grounding bus bar c/w ground screws, and ring type crimp connectors for all ground connections.		
Tagging:	Tag ALL equipment with lamacoid tags. Tag the "intrinsically safe" and "non-intrinsically safe" side of the inside of the box Tag the outside of the box "Intrinsically Safe Barrier Panel" Tags shall be black with white letters.		
References:	Canadian Electrical Code CSA C22.1 (Latest) ISA Recommended Practice for Installation of Intrinsically Safe Systems for Hazardous Locations RP12.6 (Latest) NFPA 70 Article 500 Manufacturer's Recommendations		
Panel Manufacturers:	**1st Named:** Hammond **Named Alternate:** Hoffman **Named Alternate:** Ralston		
Verification:	CSA & ISO 9002 Certified		
Date:			
Signature:			

	Uninterruptable Power Supply		
Tag No:	**DON-LS-UPS-3000**		
Location:	LEV-LS-ICP-3000		
Service:	ICP Panel UPS		
kVA Output Rating:	1500 VA		
General:			
Type:	IGBT, On Line, Double Conversion		
	Technology On Rectifier & Inverter		
Transfer Time:	Zero Break Transfer Time To Batt.		
Max. Load Current:			
Input Voltage:	85-144 Vac 1 Phase 47- 63 hz.		
Output Voltage:	120Vac 1 Phase +/- 5% @ 60 hz.		
Output Frequency:	60 Hz. ± .2 Hz.Sync With Input		
Noise Rejection:	ANSI/IEEE C62.41 (A)		
Surge Suppression:	ANSI/IEEE C62.41 (A)		
Harmonic Distortion:	< 3%		
AC Line Fail:	(-25% or + 15%) Of Nominal		
Over Load Protection:	Input Cct Breaker		
Communications:	Ethernet TCP/IP		
120 V Input/Output:	Terminal Block - see note 4		
Battery:			
Lead Acid Battery:	Sealed, Maint. Free, Hot Swapable		
Expected Life:	3-5 Years		
Reserve Time:	30 minutes @ 100% Load		
Recharge Time:	8 Hr. To 90%		
Add. Batt. Cabinets:	Size For Load/Time Requirements		
Automatic Bypass:	Internal		
Maint Bypass Switch:	External - Make Before Break		
	Independent Of UPS - see note 3		
O/P Waveform:			
On Line:	Tracks AC and Removes Noise		
On Inverter:	True Sine Wave		
Alarms:			
UPS Fault:	Dry Contact output - see note 2		
A.C. Fail:	Dry Contact output - see note 2		
Low Battery:	Dry Contact output - see note 2		
On Bypass	Dry Contact output - see note 2		
Electrical:			
Approval:	CSA and cUL		
Enclosure:	NEMA 12		
Class/Div/Group:	N/A		
Notes:	1. Mount the UPS Inside the ICP 2. Provide interposing relays if required 3. Maintenance bypass switch shall be mounted on the backplane of the ICP 4. If terminal blocks are not available provide compatible distribution terminal box for mounting in ICP		
Manufacturer:	**1st Named**		
Manufacturer:	Powerware		
Model Number:	9130 Series		
Installation:			
Serial No.:			
Calibration:	Provide Load/Time Calculations and Configuration DIP Switch Settings for Shop Drawing review		
Verification:			
Date:			
Signature:			

Programmable Logic Controller

Page 1 of 2

Allen - Bradley Programmable Controller

Hardware:

Typical Allen - Bradley CntrolLogix PLC and hardware as configured below:

Quantity	Description	
1	5580 Processor 5MB	1756-L82E
1	Ethernet Module	1756-EN2TR
1	17 Slot Chassis	1756-A17
1	ControlLogix Power supply	1756-PA75
as req'd	8 channel Analog Input Module w/ HART	1756-IF8H
as req'd	8 channel Analog Output Module w/ HART	1756-OF8H
as req'd	16 Point isolated Digital Input Module	1756-IB16I
As Req'd	16 Point Relay Output Module	1756-OW16I
As Req'd	Slot Filler	1756-N2

For selection of the type of Logix controller refer to 13010 – PLC IO Layout Appendix for all design and implementation requirements and selection criteria where information on the contract drawings is incomplete. Refer to the Bill of Materials on the panel drawings for part numbers, options and quantities.

Software:

All PLCs are to be supplied with firmware Version 19.

Manuals:

Supply two complete sets of Installation, Programming, and Communications manuals for PLC and for all specialty modules; printed/ bound and electronic (CD) format.

Notes:

1. See I/O list in Appendix 1-3 of the contract document

2. Supply 20% spare I/O of each module type (minimum) and 20% I/O space in racks.

3. Provide interposing relays for all outputs connected to solenoid valves

Programmable Logic Controller

Page 2 of 2

	Description
	Allen Bradley Programmable Controller
Notes (Con't):	4. Connect PLC and I/O modules such that the PLC system and communications to the I/O remains isolated and fully functional during communications failures between the PLC units and the Graphics Station. 5. Provide all necessary Lightning Protection Units as recommended by the PLC Manufacturer for all incoming and outgoing communications cables. 6. Submit a System Wiring/Block Diagram approved by the PLC Manufacturer with the shop drawings. c/w PLC module model numbers, cable model numbers, etc. 7. All PLC equipment shall be CSA approved for its application. 8. Provide all necessary interconnecting cables, all accessories, and all appurtenances as indicated or as required for proper operation of the system. 9. Supply, install, test, program and commission PLC components, OIT, communication equipment, and associated equipment to ensure functionality of complete network and control system. Report all construction defects, which will affect the progress of the work to the City and Consultant. The drawings have been developed on a conceptual basis. Provide devices, components and accessory items necessary for the operation of the control system Existing systems to remain functional at all times. Shut down of any of the existing equipment or system only to be performed under the direction of the Region and Consultant. All replaced or extra equipment to be delivered to the Region upon project completion. Factory Acceptance Testing (FAT) to be provided. Site Acceptance Testing and commissioning to be provided. Perform tests in accordance with Division 1, Division 13, and Division 16. Assign all warranties, licenses and product registration to the SCADA Manager at the City of Great Sudbury.
Manufacturers:	Allen Bradley Model ControlLogix
Spare Parts:	Supply one (1) of each of the following Spare Parts: 1 1756-L82E 1 1756-PA75 1 1756-IF8H 1 1756-OF8H 1 1756-IB16I 1 1756-OW16I
Installation:	
Serial No.:	
Verification:	
Date:	
Signature:	

APPENDIX 1-3
DEVICE CONTROL WIRING LIST

DON LITA LIFT STATION UPGRADES

1756-PA75	1756-L82E	1756-EN4TR	1756-N2	1756-IB16I	1756-IB16I	1756-IB16I	1756-IB16I	1756-IB16I	1756-IB16I	1756-OW16I	1756-OW16I	1756-N2	1756-IF8H	1756-IF8H	1756-OF8H	1756-OF8H	1756-N2
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

1	1756-PA75	CONTROLLOGIX POWER SUPPLY	
1	1756-A17	17 SLOT CHASSIS	
1	1756-L82E	5580 PROCESSOR 5 MB	
1	1756-EN4TR	CONTROLLOGIX ETHERNET MODULE WITH CIP SECURITY	
6	1756-IB16I	16 POINT ISOL DC INPUT MODULE	1756-TBCH
2	1756-OW16I	16 POINT RELAY OUTPUT MODULE	1756-TBCH
2	1756-IF8H	8 CHANNEL ANALOG INPUT w/ HART	1756-TBCH
2	1756-OF8H	8 CHANNEL ANALOG OUTPUT w/ HART	1756-TBNH
3	1756-N2	SLOT FILLER	
10	1756-TBCH	CONTROLLOGIX 36 PIN TERMINAL BLOCK	
2	1756-TBNH	CONTROLLOGIX 20 PIN TERMINAL BLOCK	

		USED
DI	96	48
DO	32	10
AI	16	7
AO	16	4

Don Lita Lift Station ICP-3000 I/O List

Rack	Slot	Card	Address	Type	Tag	Description
0		1756-PA75				ControlLogix Power Supply
0	0	1756-L82E				ControlLogix Processor
0	1	1756-EN4TR				Ethernet Card
0	2	1756-N2				Reserved for 2nd Communications Card
0	3	1756-IB16I	I:3/0	DI	DON-LS-RSP-3110-CS	Raw Sewage Pump 1 Control Status (0-Local; 1-Remote)
			I:3/1	DI	DON-LS-RSP-3110-MN	Raw Sewage Pump 1 Running
			I:3/2	DI	DON-LS-RSP-3110-HAS	Raw Sewage Pump 1 Emergency Stop (MCC)
			I:3/3	DI	DON-LS-RSP-3110-PWR	Raw Sewage Pump 1 Control Power Monitor
			I:3/4	DI	DON-LS-RSP-3110-XA	Raw Sewage Pump 1 VFD Fault
			I:3/5	DI	DON-LS-RSP-3110-TAH	Raw Sewage Pump 1 Motor Temperature High Alarm (Pump Monitor)
			I:3/6	DI	DON-LS-RSP-3110-XA2	Raw Sewage Pump 1 Seal Leak Alarm (Pump Monitor)
			I:3/7	DI		Spare
			I:3/8	DI	DON-LS-DRA-3001-XA	Building Intrusion Alarm - Contacts in Series
			I:3/9	DI	DON-LS-TSL-3001-TAL	Building Low Temperature Alarm
			I:3/10	DI	DON-LS-BS-3001-XA	Building Smoke Detector Alarm
			I:3/11	DI		Spare
			I:3/12	DI		Spare
			I:3/13	DI		Spare
			I:3/14	DI		Spare
			I:3/15	DI	PCS_R0S3_PWRF_DI	Rack 0, Slot 3 DI Card Blown Fuse Detection
0	4	1756-IB16I	I:4/0	DI	DON-LS-RSP-3120-CS	Raw Sewage Pump 2 Control Status (0-Local; 1-Remote)
			I:4/1	DI	DON-LS-RSP-3120-MN	Raw Sewage Pump 2 Running
			I:4/2	DI	DON-LS-RSP-3120-HAS	Raw Sewage Pump 2 Emergency Stop (MCC)
			I:4/3	DI	DON-LS-RSP-3120-PWR	Raw Sewage Pump 2 Control Power Monitor
			I:4/4	DI	DON-LS-RSP-3120-XA	Raw Sewage Pump 2 VFD Fault
			I:4/5	DI	DON-LS-RSP-3120-TAH	Raw Sewage Pump 2 Motor Temperature High Alarm (Pump Monitor)
			I:4/6	DI	DON-LS-RSP-3120-XA2	Raw Sewage Pump 2 Seal Leak Alarm (Pump Monitor)
			I:4/7	DI		Spare
			I:4/8	DI	DON-LS-LSHH-3211-LAHH	Wet Well High Well Alarm (Float Switch)
			I:4/9	DI	DON-LS-SMP-3401-MN	Sump Pump Running
			I:4/10	DI	DON-LS-SMP-3401-XA	Sump Pump Fault
			I:4/11	DI	DON-LS-LSHH-3401-LAH	Sump High Level Alarm
			I:4/12	DI	DON-LS-LSHH-3401-LAHH	Meter Chamber High Level Alarm
			I:4/13	DI	DON-LS-LIT-3211-LOE	Wet Well #1 Level Transmitter Loss of Echo (Milltronics)
			I:4/14	DI	DON-LS-FIT-3401-XA	Flow Meter General Fault
			I:4/15	DI	PCS_R0S4_PWRF_DI	Rack 0, Slot 4 DI Card Blown Fuse Detection
0	5	1756-IB16I	I:5/0	DI		Spare
			I:5/1	DI		Spare
			I:5/2	DI		Spare
			I:5/3	DI		Spare
			I:5/4	DI		Spare
			I:5/5	DI		Spare
			I:5/6	DI		Spare
			I:5/7	DI		Spare
			I:5/8	DI		Spare
			I:5/9	DI	DON-LS-MDS-3902-XAC	Main Disconnect Switch Shunt Trip Alarm
			I:5/10	DI	DON-LS-HT-001-XA	Heat Trace Unit 001 Fault Alarm
			I:5/11	DI	DON-LS-HT-002-XA	Heat Trace Unit 002 Fault Alarm
			I:5/12	DI	DON-LS-HT-003-XA	Heat Trace Unit 003 Fault Alarm
			I:5/13	DI	DON-LS-AC-3901-MN	Air Conditioner Unit Running
			I:5/14	DI	DON-LS-AC-3901-XA	Air Conditioner Unit Fault
			I:5/15	DI	PCS_R0S5_PWRF_DI	Rack 0, Slot 5 DI Card Blown Fuse Detection
0	6	1756-IB16I	I:6/0	DI	DON-LS-ICP-3000-ACPF	Control Panel AC Power Failure (Relay in ICP-3000)
			I:6/1	DI	DON-LS-ICP-3000_DCPF	Control Panel DC Power Fault (From Redundancy Module)
			I:6/2	DI	DON-LS-UPS-3001-XA	UPS Fault Alarm
			I:6/3	DI	DON-LS-TVSS-3901-XA	TVSS Surge Alarm (ICP-3000)
			I:6/4	DI		Spare
			I:6/5	DI		Spare
			I:6/6	DI		Spare
			I:6/7	DI		Spare
			I:6/8	DI	DON-LS-SPD-3901-XA	SPD Surge Protection Device General Alarm

Don Lita Lift Station ICP-3000 I/O List

Rack	Slot	Card	Address	Type	Tag	Description
			I:6/9	DI		Spare
			I:6/10	DI		Spare
			I:6/11	DI		Spare
			I:6/12	DI		Spare
			I:6/13	DI		Spare
			I:6/14	DI		Spare
			I:6/15	DI	PCS_R0S6_PWRF_DI	Rack 0, Slot 6 DI Card Blown Fuse Detection
0	7	1756-IB16I	I:7/0	DI	DON-LS-ATS-3901-CS	ATS In Control Status (0-Local; 1-Remote)
			I:7/1	DI	DON-LS-ATS-3901-NPOS	ATS in Normal Power Position
			I:7/2	DI	DON-LS-ATS-3901-NAVL	ATS Normal Power Available
			I:7/3	DI	DON-LS-ATS-3901-EPOS	ATS in Emergency Power Position
			I:7/4	DI	DON-LS-ATS-3901-EAVL	ATS Emergency Power Available
			I:7/5	DI	DON-LS-ATS-3901-XA	ATS General Alarm
			I:7/6	DI	DON-LS-ATS-3901-XAM	ATS Failure to Synchronize Alarm
			I:7/7	DI	DON-LS-ATS-3901-XAC	ATS Extended Parallel Alarm
			I:7/8	DI	DON-LS-GEN-3950-YN	Generator in Auto Mode
			I:7/9	DI	DON-LS-GEN-3950-MN	Generator Running
			I:7/10	DI	DON-LS-GEN-3950-XA	Generator General Alarm
			I:7/11	DI	DON-LS-GEN-3950-LAH	Diesel Tank Containment Leak
			I:7/12	DI	DON-LS-GEN-3950-LAL	Diesel Tank Low Level Alarm
			I:7/13	DI	DON-LS-GEN-3950-EAL	Generator Low Battery Alarm
			I:7/14	DI		Spare
			I:7/15	DI	PCS_R0S7_PWRF_DI	Rack 0, Slot 7 DI Card Blown Fuse Detection
0	8	1756-IB16I	I:8/0	DI		Spare
			I:8/1	DI		Spare
			I:8/2	DI		Spare
			I:8/3	DI		Spare
			I:8/4	DI		Spare
			I:8/5	DI		Spare
			I:8/6	DI		Spare
			I:8/7	DI		Spare
			I:8/8	DI		Spare
			I:8/9	DI		Spare
			I:8/10	DI		Spare
			I:8/11	DI		Spare
			I:8/12	DI		Spare
			I:8/13	DI		Spare
			I:8/14	DI		Spare
			I:8/15	DI	PCS_R0S8_PWRF_DI	Rack 0, Slot 8 DI Card Blown Fuse Detection
0	9	1756-OW16I	O:9/0	DO	DON-LS-RSP-3110-MH	Raw Sewage Pump 1 Run Command
			O:9/1	DO	DON-LS-RSP-3110-YNYU	Raw Sewage Pump 1 Alarm Reset
			O:9/2	DO		Spare
			O:9/3	DO		Spare
			O:9/4	DO	~~DON-LS-MDS-3902-XAC~~	~~Main Disconnect Switch Shunt Trip Alarm~~
			O:9/5	DO		Spare
			O:9/6	DO		Spare
			O:9/7	DO		Spare
			O:9/8	DO		Spare
			O:9/9	DO		Spare
			O:9/10	DO		Spare
			O:9/11	DO		Spare
			O:9/12	DO		Spare
			O:9/13	DO	ICP-3000-PL1_DO	Control Panel Communications OK Pilot Light
			O:9/14	DO	ICP_3000_PL1_ALRM_DO	Control Panel General Alarm Pilot Light
			O:9/15	DO	ICP_3000_HN1_ALRM_DO	Control Panel General Alarm Horn
0	10	1756-OW16I	O:10/0	DO	DON-LS-RSP-3120-MH	Raw Sewage Pump 2 Run Command
			O:10/1	DO	DON-LS-RSP-3120-YNYU	Raw Sewage Pump 2 Alarm Reset
			O:10/2	DO	DON-LS-GEN-3950-MH	Generator Run Command (Through ATS-3901 Remote Test Circuit)
			O:10/3	DO	DON-LS-ICP-3000-MN	ICP-3000 Energized/Health (Milltronics Pump Control Interlock)
			O:10/4	DO		Spare
			O:10/5	DO		Spare
			O:10/6	DO		Spare
			O:10/7	DO		Spare
			O:10/8	DO		Spare

Don Lita Lift Station ICP-3000 I/O List

Rack	Slot	Card	Address	Type	Tag	Description
			O:10/9	DO		Spare
			O:10/10	DO		Spare
			O:10/11	DO		Spare
			O:10/12	DO		Spare
			O:10/13	DO		Spare
			O:10/14	DO		Spare
			O:10/15	DO		Spare
0	11	1756-N2				Spare
0	12	1756-IF8H	I:12.0	AI	**DON-LS-RSP-3110-SI**	Raw Sewage Pump 1 Speed Indication
			I:12.1	AI	**DON-LS-LIT-3211-LI**	Wet Well 1 Level Indication #1 **(Milltronics)**
			I:12.2	AI	**DON-LS-FIT-3401-FI**	Total Discharge Flow
			I:12.3	AI		Spare
			I:12.4	AI		Spare
			I:12.5	AI		Spare
			I:12.6	AI		Spare
			I:12.7	AI		Spare
0	13	1756-IF8H	I:13.0	AI	**DON-LS-RSP-3120-SI**	Raw Sewage Pump 2 Speed Indication
			I:13.1	AI	**DON-LS-LIT-3221-LI**	Wet Well Level Indication #2 **(WaterPilot)**
			I:13.2	AI	**DON-LS-PIT-3401-PI**	Discharge Pressure
			I:13.3	AI	**DON-LS-LIT-3951-LI**	Generator Diesel Tank Fuel Level
			I:13.4	AI		Spare
			I:13.5	AI		Spare
			I:13.6	AI		Spare
			I:13.7	AI		Spare
0	14	1756-OF8H	O:14.0	AO	**DON-LS-RSP-3110-SC**	Raw Sewage Pump 1 Speed Setpoint
			O:14.1	AO	**DON-LS-LI-3211-LI**	Wet Well Level Indication #1 - Display on ICP-3000
			O:14.2	AO		Spare
			O:14.3	AO		Spare
			O:14.4	AO		Spare
			O:14.5	AO		Spare
			O:14.6	AO		Spare
			O:14.7	AO		Spare
0	15	1756-OF8H	O:15.0	AO	**DON-LS-RSP-3120-SC**	Raw Sewage Pump 2 Speed Setpoint
			O:15.1	AO	**DON-LS-LI-3221-LI**	Wet Well Level Indication #2 - Display on ICP-3000
			O:15.2	AO		Spare
			O:15.3	AO		Spare
			O:15.4	AO		Spare
			O:15.5	AO		Spare
			O:15.6	AO		Spare
			O:15.7	AO		Spare
0	16	1756-N2				Spare

APPENDIX 1-4
SYSTEM TAGGING

City of Greater Sudbury

System Tagging

Version 1.0

REVISION HISTORY

Version	Date	Description of Revisions
1.0	2024/09/30	• Initial Release

TABLE OF CONTENTS

1. INTRODUCTION

This Section presents a tagging system for:

- Equipment.
- Flow Streams.

1.1. Use of System Tagging in Design Documents

The device and signal tagging standard should be used in P&IDs, Process Narratives, I/O Connection and Loop Diagrams, I&C Device Location Drawings, and in the software applications. The same tagging convention may be applied to Process Flowsheets, Mechanical, and Electrical Drawings at the Designer's reasonable discretion.

Since typically all devices within a single P&ID or single I/O Connection and Loop Diagram exist within the same plant and process, individual device/signal tags on those drawings should omit the first and second code fragments. A note on the drawing in the bottom right corner (per P&ID and I/O Connection and Loop Drawing Standards) suffices to uniquely identify points on each P&ID and corresponding I/O Connection and Loop Drawing.

Where devices are specified as including a nameplate or physical equipment tag, use this Section to fully identify devices, thus ensuring logical to physical correspondence between SCADA and field device/instrument designations.

1.2. Equipment Tagging System Overview

Unique identifiers are required for each piece of equipment, device and instrument, together with unique identifiers for monitoring and control signals for the PLC/SCADA system. This system tagging applies to the whole plant irrespective of any stage expansion.

Unique identifiers are constructed from multiple code 'fragments', each of which has a pre-defined purpose, to provide the following information:

- Location within a Regional scheme, i.e., facility identification by plant.
- Location within a defined process or facility within the plant, including optional tank number.
- Device type (equipment or instrument).
- Device number or loop identifier.
- Device number extension (special case).
- For I/O data signals, to identify type and purpose within the PLC/SCADA system.

The Tag consists of fragments of an alphanumeric combination as follows:

AA	**–AAA**	**–AAAA**	**–NNNN**	**A**	**_AAAAA**
2 alpha	2 or 3 alpha	1 to 4 alpha	4 numeric	1 alpha	1 to 5 alpha
Frag 1	**Frag 2**	**Frag 3**	**Frag 4**	**Frag 5**	**Frag 6**

Where: A Denotes Alphabetic character (letter)
N Denotes Numeric character (number)

The Tag is represented by fragments, separated by dashes, which have specific functions meanings. These fragments or groups of characters are denoted by the Numbers 1 to 6 and have the following functions:

Fragment 1	This is the facility or plant identification and is a two-character alpha code representing the facility or plant location (site), i.e., WP for Wanapitei Water Treatment Plant
Fragment 2	This is the process area and is a code representing a process performed within the facility or site, i.e., TRW = Treated Water, PRM = Primary Clarification. Codes are shown in tables on following pages.
Fragment 3	This is the equipment or device description code and is a one to four-character alpha code representing the type of equipment or instrument, i.e., SC = Screen, FIT = Flow Indicating Transmitter, G = Sluice Gate. Note: While typically 4 characters is sufficient, an anomaly is a HiHi Differential Pressure Switch PDSHH that has 5 characters. Codes are shown in tables on following pages.
Fragment 4	This is the loop number and is a four-character numeric code that identifies the equipment location/loop number. Leading zeroes are used to fill the code for numbers with less than four characters, and if available the leading two-characters as used to fill in the next available tank number for example 17xx would represent tank 17 and 09xx tank 9 codes are shown in tables on following pages.
Fragment 5	Is a one-character alpha code, which differentiates between otherwise identical equipment/instruments within the same loop. This fragment is omitted if this situation does not exist. Dashes would not be used between Fragment 4 and Fragment 5. Codes are shown in tables on following pages. Example of series numbering: WP-PRM-V-0901A would indicate Primary Tank 9, Valve 1, Suction side. WP-PRM-V-0901B would indicate Primary Tank 9, Valve 1, Discharge side. WP-PRM-PIT-0901A would indicate Primary Tank 9, Pressure, Suction side. These valves and pressure transmitters would be associated with WP-PRM-P-0901 representing the first pump on Primary Tank Number 9
Fragment 6	Is an alpha code for I/O Data/SCADA Signals. Codes are shown in tables on subsequent pages on this document.

2. FRAGMENT IDENTIFICATION

2.1. Fragment 1 (Plant Location Code)

Location code is a two-character alpha code.

Frag 1	Location	Frag 1	Location
WP	Wanapitei Water Treatment Plant		

2.2. Fragment 2 (Process Area Code)

Frag 2	Meaning
AD	Admin Building
ACC	Air Conditioning, Heating and Ventilation
AER	Aeration Tanks and Diffuser System
AI	Instrument Air System
ALU	Alum
AM	Ammoniation
AMT	Atmosphere Monitoring
AST	Ash Thickening and handling system
AUX	Auxiliary System
BDIG	Sludge Blending Tank
BI	Biosolids Storage
BW	Back Wash System (Water Treatment Plant)
CG	Co-Generation
CLA	Pre-chlorination
CLB	Post-chlorination
CLC	Trim-chlorination
CSO	Combined Storm Overflow
CWS	City Water System
DCL	De-chlorination
DEW	Dewatering
DIG	Digestion
DIS	Disinfection (Chlorination and UV system)
DST	Distribution (Local Distribution – Electrical)
EN	Energy Facility (Generator and Elec. Sub Station)
ELS	Shops Electrical/Instrumentation
EPS	Effluent Pumping Station
EWS	Effluent Water System
FL	Fluoridation
FLO	Flocculation
FLT	Filtration
FPW	Filtered Plant Water
FT	Final Tanks (Water plants)
GAC	Granular Activated Carbon
GRK	Grounds Keeping
GR	Grit Removal
HW	Headworks (including screening)
HBL	HVAC System – Blower Building
HRS	HVAC System – Raw Sewage Pumping Station
HHW	HVAC System – Headworks Building
HOC	HVAC System – Odour Control Building
HP	HVAC System – Primary Service Area
HS	HVAC System – Secondary Service Area
HC	HVAC System – Central Service Area

Frag 2	Meaning
HDE	HVAC System – Disinfection and Effluent Pumping Building
HDG	HVAC System – Digestion Building
HDW	HVAC System – Dewatering Building
HIN	HVAC System – Incineration Building
HAD	HVAC System – Administration Building
INC	Incineration
ITS	Information Technology Systems
MCS	Shops Mechanical/Welding
OD	Odour Control
PA	Process Air System (Aeration Blowers and Accessories)
PAC	Powder Activated Carbon
PCL	Polyaluminum Chloride
PDIG	Secondary Digestion
POL	Polymer
PRM	Primary Treatment or Primary Clarification
PRS	Phosphorus Removal System
RM	Residue Management
RSP	Raw Sewage Pumping (For pumping stations only)
RW	Raw Water
SA	Service Air (Non-Instrument or Process)
SDIG	Primary Digestion
SED	Sedimentation
SLD	Sludge Drying
SLO	Sludge Loading Station
SM	Spill Management
SPC	System Process Control
STR	Secondary Treatment (Secondary Clarification)
SMP	System Monitoring Points
THK	Sludge Thickening
TRW	Treated Water
VEH	Vehicles
ZMC	Zebra Mussel Control
WCP	Water Circulation Program
WW	Waste Water

2.3. Fragment 3 (Device Type Code)

2.3.1. Equipment Codes

Frag 3	Equipment Description
AF	Anaerobic Filter
AHU	Air Handling Unit
AM	Atmosphere Monitoring
ANL	Analyser
AAD	Alarm Auto Dialer
AC	Air Conditioning Unit
ART	Air Receiver Tank
BOX	Box
BAT	Battery
BFP	Backflow Preventer
BL	Blower
BO	Boiler
BT	Blending Tank
BU	Burner
BRC	Breaching

Frag 3	Equipment Description
C	Compressor
CAP	Capacitor
CB	Circuit Breaker (also see PLB)
CC	Cross Collector
CLR	Clarifier
CF	Centrifuge
CH	Chamber
CL	Classifier (Grit)
CPU	Computer
CHL	Chlorinator
CI	Chiller
CM	Collector Mechanism
CMP	Compactor
COM	Communications Equipment, Lan, Telephone
CP	Control Panel
CT	Controller, Temperature
CU	Condensing Unit
CUS	Chemical Unloading Station
CV	Conveyor Equipment (belt, bucket, screw, etc.)
CYC	Cyclone, Vortex
D	Air Dryer/Dehumidifier
DA	Deaerator
DD	Display Device (Data Panel Monitor)
DM	Damper, Louvre
DPM	Digital Power Monitor
DRA	Door Alarm
DRV	Drive Electric, Mechanical
DU	Ducting
DCS	Diffuser Cleaning System
ENG	Engine
EVA	Elevator Alarm
EV	Evaporator
EWS	Eye Wash Shower
F	Filter
FA	Fire Alarm System
FEQ	Fire related Equipment
FP	Filter Press
FEBU	Feeder Electrical (Includes Busbars of any Voltage)
FD	Feeder, Chemical
FN	Fan
FU	Furnace
FX	Flame Arrestor
FBR	Fluidized Bed Reactor
FBX	Fiber Box Panel
G	Sluice Gate
GB	Gas Booster
GEN	Generator
GDR	Grinder, Comminutor
GR	Gear Box
HE	Heat Exchanger, Evaporator
HU	Humidifier
HTR	Heater
ICP	Instrument Control Panel
ICH	Network Switch

Frag 3	Equipment Description
LAG	Lagoon
LB	Load Break Switch
LCP	Local Control Panel
LD	Lifting Device
LG	Level Gauge
LP	Lighting Panel
LTG	Lighting
LCS	Local Control Station (Push Button station)
M	Motor
MCC	Motor Control Centre
MX	Mixer, Flocculator and Agitator
MCP	Master Control Panel
OTF	Outfall Structure
OZ	Ozonator
OT	Oil Tank
[XX]P	Pump, where [XX] is the process flow identification based on the first 2 letters of the project flow identification stream as identified by the Flow Stream Identification Table included in this section. Examples are listed below:
	PMP = Pumps (general)
	ASP = Ash Slurry Pump
	GRP = Grit Pump
	HLP = High Lift Pump
	RSP = Raw Sewage Pump
	PSP = Primary Sludge Pump
	RAP = Return Activated Pump
	WAP = Waste Activated Pump
PA	Public Address System
PD	Primary Digester
PDP	Power Distribution Panel
PLBx	Primary Load Breaker x (use only for main substation; also see CB)
PRT	Printer
PLC	Programmable Logic Controller
PS	Power Supply
QUEN	Quencher
RC	Recorder
REC	Reactor
RIO	Remote IO Unit
RES	Reservoir
RST	Rotating Skimmer Trough
SB	Scrubber (air, gas)
SC	Screen, Trash Rack,
SCAM	Security Camera Motion Detection
SCAN	Security System Scanner
SD	Secondary Digester
SERV	Server
SO	Sulphonator
SP	Sampler/Sampling Point
ST	Starter
STR	Strainer
SWG	Switchgear
SS	Sanitary Sump
SIL	Silencer
T	Tank, Vessel
TB	Tie Breaker

Frag 3	Equipment Description
TR	Transformer
UPS	Uninterruptible Power Supply
UV	Ultra-Violet Reactor
V	Valve
VENT	Vent
WSC	Weigh Scale Station
WEL	Well

2.3.2. Instrument Codes

Frag 3	Instrument/Signal Description
AE	Analyzer Element
ASH	Analysis Switch High
ASL	Analysis Switch Low
ART	Analysis Recording Transmitter
AIT	Analysis Indicating Transmitter
BNG	Burner Natural Gas
BSG	Burner Sewage Gas
ERT	Voltage Recording Transmitter
EIT	Voltage Indicating Transmitter
FE	Flow Element
FSH	Flow Switch High
FSL	Flow Switch Low
FRT	Flow Recording Transmitter
FI	Flow Indicator or Gauge
FIC	Flow Indicating Controller
FIT	Flow Indicating Transmitter
FQ	Flow Totalizing Meter
FQIR	Flow Totalizing Indicating Recorder
FS	Flow Switch
HS	Hand Switch (or Pushbutton)
HMS	Hand Momentary Switch (or Pushbutton)
IRT	Current Recording Transmitter
IIT	Current Indicating Transmitter
IT	Current Transformer
JRT	Power Recording Transmitter
JIT	Power Indicating Transmitter
JSL	Power Switch Low (Power Failure Relay)
KI	Time Indicator (Clock)
KIQ	Total Runtime Meter
LDIT	Level Differential Indication Transmitter
LE	Level Element
LI	Level Indicator or Gauge
LIC	Level Indicating Controller
LSH	Level Switch High
LSHH	Level Switch High-High
LSL	Level Switch Low
LRT	Level Recording Transmitter
LIT	Level Indicating Transmitter
LT	Level Transmitter
PE	Diaphragm or Annular Diaphragm
PDIT	Pressure Differential Indicating Transmitter
PDSH	Pressure Differential Switch High
PDSHH	Pressure Differential Switch High High

Frag 3	Instrument/Signal Description
PSH	Pressure Switch High
PSHH	Pressure Switch High High
PSL	Pressure Switch Low
PSLL	Pressure Switch Low Low
PRT	Pressure Recording Transmitter
PI	Pressure Indicator or Gauge
PIC	Pressure Indicating Controller
PIT	Pressure Indicating Transmitter
SC	Potentiometer.
SI	Speed Indicator or Gauge
SIT	Speed Indicating Transmitter
SRT	Speed Recording Transmitter
SSH	Speed Switch High
SSL	Speed Switch Low
TE	Temperature Element
TSH	Temperature Switch High
TSL	Temperature Switch Low
TRT	Temperature Recording Transmitter
TI	Temperature Indicator or Gauge
TIC	Temperature Indicating Controller, Thermostat
TIT	Temperature Indicating Transmitter
VSH	Vibration Switch High
VSL	Vibration Switch Low
VRT	Vibration Recording Transmitter
VI	Vibration Indicator
VIT	Vibration Indicating Transmitter
VE	Vibration Element
WSH	Weight/Force/Torque Switch High
WSL	Weight/Force/Torque Switch Low
WRT	Weight/Force/Torque Recording Transmitter
WIT	Weight/Force/Torque Indicating Transmitter
XSF	Shear PIN
YAN	Alarm Horn
YL	Status Light
ZIC	Position Indicating Controller
ZSH	Position Switch High (Open)
ZSLH	Position Switches Low and High
ZSL	Position Switch Low (Closed)
ZRT	Position Recording Transmitter
ZIT	Position Indicating Transmitter

2.4. Fragment 4 (Location/Loop Number)

Fragment 4 always consists of a four-digit numeric number. Leading zeros shall be added where required.

Any device which is common to a process area or plant will have two leading zeros. Devices that are related to a stream will carry the base number of the stream. See examples below:

Example: Primary Treatment

- Primary Clarifier 1 Tank would carry a Tag of: XX-PRM-T-0100.
- Primary Clarifier 1 Sludge Collector would carry a Tag of: XX-PRM-CM-0100.

- Level Transmitter for Primary Clarifier Tank 1 would carry a Tag of: XX-PRM-LIT-0101.
- Primary Sludge Pump 1 for Primary Clarifier 1 would carry a Tag of: XX-PRM-PSP-0101.
- Primary Clarifier 14 Sludge Collector would carry a Tag of: XX-PRM-CM-1400.
- Primary Sludge Pump 1 for Primary Clarifier 14 would carry a Tag of: XX-PRM-PSP-1401.

2.5. Fragment 5 (Device Number EXTENSION)

Use the device number extension when more than one device of the same type exists together for one base number (for example pump). Examples include ultrasonic transmitters with multiple sensing heads – one device produces multiple signals representing the levels in different locations; or dual-head level sensors where a single transmitter is wired to two different sensors. See example below:

- Suction Pressure Switch for Return Activated Sludge Pump 1 for Secondary Clarifier 1 would carry a Tag of: XX-STR-PSL-0101.

- Discharge Pressure Switch for Return Activated Sludge Pump 1 for Secondary Clarifier 1 would carry a Tag of: XX-STR-PSH-0101.

If there are two Low Pressure Switches, one for Suction and other for Discharge, then the Suction Side Low Pressure Switch will carry a Tag of: XX-STR-PSL-0101A and the Discharge Side Low Pressure Switch would carry a Tag of: XX-STR-PSL-0101B.

If there are Suction and Discharge Motorized Valves for Return Activated Sludge Pump 1, then the suction side valve would carry a Tag of: XX-STR-V-0101A and the Discharge Side Valve will carry a Tag of: XX-STR-V-0101B.

2.6. Fragment 6 (Data/SCADA Signal Code)

Data Signal code usage covers signals related to both real I/O in the I&C/SCADA design, and virtual I/O, e.g., points derived from a single analog signal such as average, minimum, maximum, total flow, etc., all developed in software from a single flow transmitter. Other virtual signal types are those communicating between the PLC and the HMI, or a specific signal in the software.

As a minimum, signals and data points are to be assigned point names for all data transferred between programmable devices and all points in the Human-Machine Interface (HMI) and the historical databases unless otherwise stated in the software standards.

Most of the commonly used signal/SCADA codes are included in the following table:

Replace "x" in the following table with an ISA "FIRST LETTER" such as P (pressure), "F" (flow), "T" (temperature), "W" (torque), etc.

SCADA/Signal Code	Signal Description
xAH	"x" Hi Alarm
xAHH	"x" HiHi Alarm
xAHL	"x" High/Low Alarm
xAL	"x" Lo Alarm
xALL	"x" LoLo Alarm
xAOH	Out of Range High
xAOL	Out of Range Low
xASG	Signal Error
xASI	Deviation Alarm "x"

SCADA/Signal Code	Signal Description
xAW	"x" Alarm Warning
xC	"x" Control/Setpoint
xI	"x" Indication
CKDY	PLC Current Day
CKHR	PLC Current Hour
CKMN	PLC Current Minute
CKMT	PLC Current Month
CKSC	PLC Current Second
CKYR	PLC Current Year
CNT	Number of Starts
CNTHI	High Number of Starts
COMA	Communication Alarm
DBH	Hi Deadband
DBHH	HiHi Deadband
DBL	Lo Deadband
DBLL	LoLo Deadband
EA	Voltage Phases A-B
EAL	Loss of Power Alarm
EB	Voltage Phases B-C
EC	Voltage Phases C-A
ENH	Hi Enable
ENHH	HiHi Enable
ENL	Lo Enable
ENLL	LoLo Enable
EUMN	Engineering Unit Minimum
EUMNS	Speed Engineering Unit Minimum
EUMNZ	Stroke Engineering Unit Minimum
EUMX	Engineering Unit Maximum
EUMXS	Speed Engineering Unit Maximum
EUMXZ	Stroke Engineering Unit Maximum
H	Hi Limit
HAS	Emergency Stop
HBRIO1	Remote IO Rack 1 Heartbeat Alarm
HBRIO2	Remote IO Rack 2 Heartbeat Alarm
HBRIO3	Remote IO Rack 3 Heartbeat Alarm
HBRIO4	Remote IO Rack 4 Heartbeat Alarm
HBRIO5	Remote IO Rack 5 Heartbeat Alarm
HBRIO6	Remote IO Rack 6 Heartbeat Alarm
HH	HiHi Alarm Limit
HHT	HiHi Limit Temporary
HISI	Speed Automatic Setpoint
HIYU	Computer Auto Mode Request
HIYUS	Speed Computer Auto Mode Request
HIYUZ	Stroke Computer Auto Mode Request
HIZISC	Stroke Automatic Setpoint
HSMH	Manual Start Request
HSMHH	Manual Start Request High Speed
HSMHL	Manual Start Request Low Speed
HSML	Manual Stop Request, Drive or Valve
HSSI	Speed Manual Setpoint
HSVH	Manual Open Request
HSVL	Manual Close Request
HSYU	Computer Manual Mode Request
HSYUS	Speed Computer Manual Mode Request
HSYUZ	Stroke Computer Manual Mode Request
HSZIO	Manual Mode Position Setpoint

SCADA/Signal Code	Signal Description
HSZISC	Stroke Manual Setpoint
HT	Hi Limit Temporary
II	Current Draw Indication
IIA	Current – Phase A
IIB	Current – Phase B
IIC	Current – Phase C
JQ	Energy
KQ	Runtime (Hours)
KQYU	Runtime Reset
L	Lo Limit
LBAT	Low Battery Fault
LK	Process Lockout Alarm
LK1	Process Lockout Alarm 1
LK2	Process Lockout Alarm 2
LK3	Process Lockout Alarm 3
LK4	Process Lockout Alarm 4
LK5	Process Lockout Alarm 5
LL	LoLo Limit
LLT	LoLo Limit Temporary
LT	Lo Limit Temporary
MB	Running Status
MBH	Running High Speed
MBL	Running Low Speed
MF	Motor Failed
MH	Start Command
MHF	Start Command Forward
MHH	Start Command High Speed
MHL	Start Command Low Speed
MHR	Start Command Reverse
MHS	Start Setpoint
MHYA	Restart Inhibitor
MHYA_RM	Restart Inhibitor Time Remaining
MHYAH	Restart Inhibitor High Speed
MHYAH_RM	Restart Inhibitor Time Remaining High Speed
MHYAL	Restart Inhibitor Low Speed
MHYAL_RM	Restart Inhibitor Time Remaining Low Speed
ML	Stop Command
MLS	Stop Setpoint
MMH	Run Command High Speed
MML	Run Command Low Speed
Name	Description
OS	In Service/Out of Service
OVSW	Long Scan Time
RF	Refresh Alarm Limits
RFQXA	Sequence Error
RFS	Setpoint Update
RFSQ	Sequence Update
RFSXA	Setpoint Error
RFXA	Alarm Limit Check Fail
ROC	Rate Of Change Alarm
RWIN	Raw Analog Input Value
RWSI	Raw Speed Input Value
RWZI	Raw Stroke Input Value
RWZIS	Raw Stroke Input
SC	Speed Output
SI	Speed Feedback

SCADA/Signal Code	Signal Description
SQ	Sequence Number
SQA	Sequence Aborted Alarm
SQH	Sequence Holding/Waiting
SQI	Sequence Inhibited/No Permissive
STS	PLC Status
TMH	Hi Time Delay
TMHH	HiHi Time Delay
TMHS	Start Setpoint Temporary
TML	Lo Time Delay
TMLL	LoLo Time Delay
TMLS	Stop Setpoint Temporary
TSQ	Sequence Temporary
VH	Open Command
VL	Close Command
XA	General Alarm
XA	General Alarm
XAAP	Application Fault
XABAT	Battery Failure
XAC	Critical Alarm
XACPU	CPU Hardware Problem
XACR	Controller Fault
XACRF	Controller Fault Table Full
XACRP	Controller Fault Present
XAHD	Hardware Fault
XAI	Instrument Failure Alarm
XAIO	IO Fault
XAIOC	IO Module Communication Error
XAIOF	IO Fault Table Full
XAIOP	IO Fault Present
XAMH	Fail to Start Alarm
XAMHFR	Fail To Start Forward Alarm
XAMHH	Fail To Start High Speed Alarm
XAMHHU	Uncommanded Start High Speed Alarm
XAMHL	Fail To Start Low Speed Alarm
XAMHLU	Uncommanded Start Low Speed Alarm
XAMHR	Fail To Start Reverse Alarm
XAMHU	Uncommanded Start Alarm
XAMHUFR	Uncommanded Start Forward Alarm
XAMHUR	Uncommanded Start Reverse Alarm
XAML	Fail to Stop Alarm
XAMLU	Uncommanded Stop Alarm
XAOHS	Speed Out of Range High Alarm
XAOHZ	Stroke Out of Range High Alarm
XAOLS	Speed Out of Range Low Alarm
XAOLZ	Stroke Out of Range Low Alarm
XARAM	Corrupted RAM
XASGS	Speed Signal Error
XASGZ	Stroke SIgnal Error
XASIS	Speed Devation Alarm
XASIZ	Stroke Deviation Alarm
XASW	Software Fault
XAZ	Unknown Position Alarm
XAZH	Fail To Open
XAZHU	Uncommanded Open
XAZL	Fail To Close
XAZLU	Uncommanded Close

SCADA/Signal Code	Signal Description
YA	Device Alarm
YA1	Device Alarm 1
YA2	Device Alarm 2
YA3	Device Alarm 3
YA4	Device Alarm 4
YA5	Device Alarm 5
YAN	Not Available
YI	Permissive
YN	Computer Mode
YNHS	Computer Manual Mode
YNHSS	Speed Computer Manual Mode
YNHSZ	Stroke Computer Manual Mode
YNMH	Automatic Start Request
YNMHH	Automatic Start Request High Speed
YNMHL	Automatic Start Request Low Speed
YNML	Automatic Stop Request, Drive or Valve
YNS	Speed Computer Mode
YNVH	Automatic Open Request
YNVL	Automatic Close Request
YNYN	Computer Auto Mode
YNYNS	Speed Computer Auto Mode
YNYNZ	Stroke Computer Auto Mode
YNZ	Stroke Computer Mode
YNZIC	Automatic Mode Position Setpoint
YU	Alarm Reset
YUA	Acknowledge
YUF	PLC Fault Table Reset
YUIF	PLC IO Fault Table Reset
YURF	Refresh Reset
YURFQ	Sequence Error Acknowledge
YURFS	Setpoint Error Acknowledge
YUST	Start Count Reset
ZH	Open Position
ZIS	Stroke Feedback
ZISC	Stroke Output
ZL	Close Position
ZXA	Position Deviation Alarm

Codes for other signals and data not found in the list above can be generated using the following guidelines:

1. Use ISA coding methods and the above standard instrument letter identification tables.

2. Use the abbreviation “A” for analysis for all analytical measurements; do not use chemical abbreviations (e.g., CL2, FE, FECL2, O2), laboratory test designations (e.g., TSS, SS, NTU,) or other abbreviations (e.g., DEN for density, LEN for length).

3. Use abbreviations for measured variable; do not use “X” to denote the measured variable.

4. Create as few special codes as practical. Data point names need to be unique within a PLC or within the Plant wide HMI environment. Data names do not need to describe the datum; the description belongs in the description field.

5. Use abbreviations in a consistent manner. That is, use only one abbreviation for the same meaning.

6. Use a hyphen or an underscore to separate portions of the data code if needed to clarify the name. Use no other special characters.

7. Use the following abbreviations as needed:

Abbreviation	Meaning
ACT	Actual
BLK	Block
C	From SCADA, usually as the last letter in a data code
CLK	Clock
COND	Conditioned
CV	PID "CV" Control Variable
DB	Deadband
DT	Day of Week
DUPL	Duplicate
DV	Device
DY	Day of Month
EN	Enable
FLT	Fault
HR	Hour
ID	Identity
JOG	Jog
L	Latched, usually as the last letter in a data code
MAX	Maximum
MIN	Minimum or Minute
MTH	Month
ND	Needed, Required
NOR	Normal
OK	Okay, Successful
OS	Out of Service
OV	Over
PID	Proportional Integral Derivative
PRE	Preset
PV	PID “PV” Process Feedback
READ	Read
REQ	Request
RF	Refresh
RS	Restart
SEC	Second
SEL	Select
SP	Setpoint
SQ	Sequence
T	Timer, usually as the first letter in a data code for a system variable
T	Temporary, usually as the last letter in a data code
TMP	Temporary
TMR	Timer
TRAN	Transition
UN	Under
VAL	Value
W	Word, followed by the number of the word
WRI	Write
YR	Year

3. FLOW STREAM IDENTIFICATION

The flow streams for the process piping are identified per the table below. These flow streams are combined with the pumping equipment (P) equipment descriptor to identify the pump, for example, RSP = Raw Sewage Pump.

Code	Flow Steam Identification
AA	Atmospheric Air
AHP	Air, High Pressure Process
AI	Air, Instrument
ALB	Air, Laboratory
ALP	Air, Low Pressure Process
ARCY	Anoxic Recycle
ARD	Acid Resistant Drain
ARV	Acid Resistant Vent
AS	Air Scour
ASL	Ash Slurry
ASPD	Acid Sump Pump Discharge
ASS	Ash Supernatant
AV	Acid Vent
AW	Acid Waste
BAWD	Backwash Drain
BD	Biofilter Drain
BEEP	Bypass
BFE	Bio-Filter Effluent
BFI	Bio-Filter Influent
BFR	Bio-Filter Recycle
BFW	Boiler Feed Water
BN	Bioscrubber Nutrient
BP	Backpulse Solution
BR	Brine Solution
BRI	Biological Reactor Influent
BS	Blended Sludge
BWD	Backwash Drain
BWR	Backwash Return
BWS	Backwash Supply
BWW	Backwash Waste
BYP	Bypass
CA	Compressed Air
CCB	Carbon Contactor Backwash Water
CCE	Carbon Contactor Effluent
CCI	Carbon Contactor Influent
CE	Chlorinated Effluent
CGS	Cooling Glycol Supply
CGR	Cooling Glycol Return
CHWR	Chilled Water Return
CHWS	Chilled Water Supply
CIP	Clean-in-place Solution
CO	Condensate Drain
COA	Contaminated Air
CSD	Chemical Sump Discharge
CSF	Carbon Slurry Flush
CSM	Concentrated Scum
CTW	Contactor to Waste
CW	Condenser Water

Code	Flow Steam Identification
CWR	Cooling Water Return
CWS	Cooling Water Supply
D	Drain (Sanitary)
DC	Dewatering Centrate Recycle
DCW	Decant Water
DEX	Dryer Exhaust
DG	Digester Gas
DI	Distilled Water
DIW	Deionized Water
DR	Drain
DS	Digested Sludge
DSC	Dewatered Sludge Cake
DSN	Digester Supernatant
DUS	Dust
DW	Distilled Water
DWC	Dewatering Centrate
EA	Exhaust Air
EFF	Effluent
EOF	Emergency Overflow
EQE	Equalization Effluent
EQI	Equalization Influent
EWW	Eyewash Water
EX	Exhaust Air
F	Filtrate
FCS	Fresh Carbon Slurry
FD	Fire Protection Dry Standpipe
FE	Filter Effluent
FEX	Furnace Exhaust
FF	Fire Suppression Foam
FI	Filter Influent
FO	Fuel Oil
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
FPF	Fire Protection Foam
FS	Fire Protection Water Supply – Wet
FTW	Filter to Waste
FW	Finished Water
G	Natural Gas
GAS	Gasoline
GR	Grit Slurry
GW	Ground Water
H	Hydrogen Gas
HFR	Hydraulic Fluid Return
HFS	Hydraulic Fluid Supply
HGR	Heating Glycol Return
HGS	Heating Glycol Supply
HPHW	High Pressure Hot Water
HS	High Service
HW	Hot Water (Domestic)
HW2	Hot Service Water
HWR	Heating Water Return
HWS	Heating Water Supply
IA	Instrument Air
IS	Imported Sludge
LA	Laboratory Air

Code	Flow Steam Identification
LC	Leachate
LCW	Laboratory Cold Water
LG	Lubrication Grease
LHW	Laboratory Hot Water
LO	Lube Oil
LOX	Liquid Oxygen
LPG	Liquefied Petroleum Gas
LPO	Liquid Polymer
LPR	Low Pressure Return (Condensate)
LPS	Low Pressure Steam
LRHW	Laboratory Recirculating Hot Water
LV	Laboratory Vacuum
MD	Membrane Drain
MF	Membrane Feed
MG	Natural Gas (Medium Pressure)
ML	Mixed Liquor
MOL	Methanol
MP	Membrane Permeate
MPR	Medium Pressure Return (Condensate)
MPS	Medium Pressure Steam
MS	Methanol Solution
NG	Natural Gas
NRCY	Nitrate Rich Recycle
OA	Odorous Air
OD	Overflow Drain
OF	Overflow
ORD	Overflow Roof Drain
OZ	Ozone
OZW	Ozonated Water
P	Propane Gas
PAE	Post Aeration Effluent
PD	Plant Drain
PDD	Plant Drain Discharge
PE	Primary Effluent
PI	Primary Influent
PLE	Plant Effluent
PS	Pressure Sewer
PSD	Primary Sludge
PSM	Primary Scum
PWE	Plant Waste Effluent
RAS	Return Activated Sludge
RCW	Recirculating Cooling Water
RD	Roof Drain
RDS	Recirculated Digested Sludge
REC	Recirculation
RHW	Recirculated Hot Water
RO	Reverse Osmosis
RPS	Return Primary Sludge
RS	Raw Sewage
RW	Raw Water
S	Sanitary Sewer (Gravity)
SA	Sample
SAB	Scrubber Acid Blowdown
SAC	Spent Activated Carbon
SBC	Caustic Scrubber Blowdown

Code	Flow Steam Identification
SC	Scum Concentrate
SCR	Screenings
SCS	Spent Carbon Slurry
SD	Storm Drain
SDW	Scrubber Drain Water
SE	Secondary Effluent
SEP	Septage
SI	Secondary Influent
SL	Salt
SPD	Sump Pump Drain
SPEO	Screened Primary Effluent Overflow
SR	Scrubber Recycle
SS	Sanitary Sewer
SSM	Secondary Scum
STG	Stack Gas
TASL	Thickened Ash Slurry
TC	Thickening Concentrate
TS	Thickened Sludge
TWAS	Thickened Waste Activated Sludge
TWS	Tempered Water Supply
UD	Under Drain
UVE	UV Effluent
V	Vent
VAC	Vacuum
VR	Vapour Recovery
VTR	Vent Through Roof
W1	No. 1 (Potable) Water
W2	No. 2 (Nonpotable) Water
W3	No. 3 Water
W4	No. 4 Water
WAS	Waste Activated Sludge
WSP	Wet Standpipe
WWD	Washwater Drain
WWS	Washwater Supply

END OF SECTION

APPENDIX 2-1
PROCESS CONTROL NARRATIVE

1 PROCESS CONTROL LOGIC

1.1 Modes of Operation

The modes of operation for the major equipment associated with the Don Lita Lift Station are summarized in the following table. Local Manual and Hardwired Control operation is through operation of local pushbuttons and controls at the device itself or from the equipment MCC panel. Remote operation of equipment is through the SCADA system.

Table 1: Modes of Operation

EQUIPMENT DESCRIPTION	LOCAL	REMOTEPLANT MANUAL	REMOTE PLANT AUTO	HARDWIRED CONTROL
Sewage Lift Pump Duty 1 (VFD)	√	√	√	√
Sewage Lift Pump Standby 2 (VFD)	√	√	√	√
ATS	√			
Generator	√	√		√

1.2 Hardwired Interlocks

The hardwired interlocks at the station are intended to prevent damage to the equipment. The following interlocks are hardwired in the pump control circuit.

i. Motor protection relay/Overload Fault.
ii. VFD Fault.
iii. High Temperature/Leakage Fault.
iv. Emergency Stop Push Button.
v. Back-up Control Mode/Level Transmitter Low Level Alarm.

Overload, High Temperature, and VFD Fault interlocks immediately shuts down the associated pump in all modes and generates an alarm on the SCADA system. The associated alarm can be reset from a local reset pushbutton located on the MCC or pump panel.

Putting a pump in local mode will bypass all interlocks programmed in the PLC code. A low level interlock will automatically shut down the pump. In addition, pumps in local mode will not be operated by hardwired backup circuits.

1.3 Hard Wired Backup Control (Local – Auto Mode)

In the event of a failure of the PLC to operate the pumps as required, the Backup Control Mode will operate through the use of the low and high level wet well ultrasonic level transmitter (LIT3211) relays to activate the pumps. When the wet well level rises above the normal PAC system operating range, the backup control is active for the pumps in REMOTE mode, and it is independent of Remote Plant Manual (PLT-MAN) and Remote Plant Auto (PLT-AUTO) mode. Each pump is provided with individual start and stop signals from the Miltronics Level Transmitter relays. Normal control mode will be provided by the Water Pilot level probe.

In backup control, the pumps will start and stop based on the setpoints programmed into the wet well ultrasonic level transmitter. Pump #1 will have the lower start level and therefore would start first. On rising wet well level Pump #1 will start when its start level relay activates and will continue running until the wet well level falls below the Pump #1 stop level relay, at which time it will stop. If the level continues to rise to the point where Pump #2 start relay is activated, then Pump #2 will start and continue to run until the level falls below the Pump #2 stop relay. This cycle will continue until the PAC system resumes operation.

If at any time the wet well level drops below the Stop Level relay setpoint, operation of the pumps will automatically stop.

Under normal operating conditions the station level is controlled by the water pilot – hydrostatic pressure probe with field meter transmitter to measure the wet well level. The secondary level control is from the ultrasonic level transmitter (HART communication protocol enabled) utilizing the Siemens Miltronics 200 transmitter with 6 output replays (for backup controls). The start and stop setpoints as well as the duty control are directly adjustable from the plant SCADA HMI. If the level measured within the local station deviates outside the normal operational range, the SCADA system will switch the control level to the secondary level transmitter (ultrasonic).

1.4 Remote Control

In the REMOTE position the pumps are controlled through the PLC in either PLT-MAN or PLT-AUTO mode. In the PLT-MAN mode the operator start/stop the pumps through the SCADA system. In the PLT-AUTO mode the start/stop of the pumps is based on wet well level and start/stop setpoints defined by the operator. The pumps start and stop automatically based on the wet well level setpoints. The wet well level transmitter signal (4-20 mA) is scaled within the PLC according to the wet well size. When the level rises to the Duty 1 start level setpoint, the Duty 1 pump starts. When the level increases to the Duty 2 start level setpoint, the Duty 2 pump starts. When the level drops to the Duty 2 stop level setpoint, the Duty 2 pump stops. When the level drops to the Duty 1 stop level setpoint, the Duty 1 pump stops. This cycle will continue as the wet well level rises and falls.

1.5 Standby Power Mode

Upon detection of power failure, the standby diesel generator will activate. Once power is being supplied by the diesel generator, the ATS will move from its normal position (accepting power from the standard hydro feed) to the backup position. At this point, the station is now receiving power and is ready to resume operations in order to provide water to the distribution system.

Once the diesel generator is supplying power to the station, operations staff can initiate start and stop operations for any of the equipment at this site.

The operator can decide to test the function of the standby power system at this facility by toggling the ATS to test mode. The ATS will then command the diesel generator to run, and once operational will switch the station to diesel power. The operator can then discontinue the operation of the diesel generator by toggling the ATS back to auto mode. This will allow the ATS to return to the Normal Power position and command the diesel generator to stop.

All pumps are equipped with a LOCAL-REMOTE selector switch mounted at the MCC or local to the device. In the LOCAL position the pumps are operated through the START/STOP pushbuttons at the MCC. All pumps will have a locally mounted E-STOP. In the REMOTE position the pumps are controlled through the PLC in either PLT-MAN or PLT-AUTO mode. In PLT-MAN mode the operator start/stop the pumps through the SCADA system.

1.6 Pump Capacities

Table 2: Pump Capacities

Pumps	Pump Size	Maximum Flow	Minimum Flow
Pump 1	70L/s	70 L/s	26 L/s
Pump 2	70 L/s	70 L/s	26 L/s

1.7 Control Parameters

1. For each Pump, there is the ability to enter Start and Stop level setpoint (in %).
2. The Level Transmitter (used in auto control of the pumps).
3. There is an option to Enable or Disable the Intrusion alarm. The selected choice will be displayed in green or magenta.

4. The Timed Duty Rotation section will display the number of days and amount of time that the system has been in a particular duty rotation mode.

The PLC program carries out the error check for the duty pumps level setpoints when updating the level setpoints from HMI entry. Setpoints are transferred via the Setpoint Update button on the associated screen. If an error occurs with the operator entered start and stop levels, the existing start and stop setpoints are copied back to the temporary values and an error message is displayed on the setpoint entry screen. The original Setpoints remain unchanged. All Start/Stop levels are separated from each other by a dead band which is not adjustable via the SCADA system or local HMI. The minimum dead band will be 5% unless it is indicated during commissioning that it needs to be changed. Level Setpoints are limited within the pump station PLC error checking logic to be within a specific percentage of span.

1.8 Pump Duties

For each duty pump, there is ability to enter the position setpoints. The current pump position is also displayed for monitoring purposes.

When Pump 1 is selected as the Duty 1 pump, the other pump must be selected to Duty 2 or Standby. The duty pump selections will only be in affect when a pump is in PLT-AUTO mode.

Once the assignment of duties is made to each of the pumps, it is required to press the “Update” button for the settings to take effect.

1.9 Pump Duty Rotation (Alternating)

Three methods of pump duty rotation are available to the operator from the HMI. The 3 Modes of Operation are All Pumps stopped, timed interval and Disabled. The Disabled Mode inhibits all automatic duty rotation including on pump failure.

1. Disabled Mode:

   In this mode the pump duty does not automatically rotate.

2. All Pumps Stopped Mode:

   Duty is rotated at the moment when all pumps are stopped. If the new duty pump is not available, the duty will be replaced with the next available duty.

3. Timed Interval:

   Duty rotation will be based on a time interval setpoint that is entered from the HMI. The operator can select a time setpoint between 0-10 days as well as 0-23 hours in one hour increments. In this mode, when the interval time has elapsed, the pump selected as Duty 2 will change to Duty 1 and the Duty 1 pump will change to Duty 2/Standby immediately.

4. Hourly Timed Interval:

   Duty rotation will be based on a time interval setpoint that is entered from the HMI. The operator can select a time setpoint between 0-24 hours in one hour increments. In this mode, when the interval time has elapsed, the pump selected as Duty 2 will change to Duty 1 and the Duty 1 pump will change to Duty 2/Standby immediately. The timer restarts immediately from the last time the mode was selected and/or upon completion of a duty rotation.

APPENDIX 4-1
INSTRUMENT CHECK AND SIGN-OFF SHEETS

P.N. _____	**INSTRUMENTATION CHECKLIST** **Calibration**	**Contract #:** **City Project #:** **Project Name:**

File:	**Date:**
Description:	**Tag:**

Tag Number	Serial Number	Data Sheet Number	Calibrated per Data Sheet	Checked by (Initial)	Date

Approvals: The signatures below do NOT absolve the contractor from any of his contractual obligations.

Authority	Name	Signature	Date
Contractor			
Owner			
Consultant			
_____Maintenance			
_____E & S			

P.N. _____	**INSTRUMENTATION CHECKLIST** **Termination and Continuity**	**Contract #:** **City Project #:** **Project Name:**

File:	**Date:**
Description:	**Tag:**

Tag Number	Loop Drawing Number	Terminations per Drawing	Continuity Checked	Checked by (Initial)	Date

Approvals: The signatures below do NOT absolve the contractor from any of his contractual obligations.

Authority	Name	Signature	Date
Contractor			
Owner			
Consultant			
_____ Maintenance			
_____ E & S			

REF. NO. _____

P.N. _____

INSTALLATION CHECKLIST
EQUIPMENT – ELECTRICAL

EQUIP. NO. _____

CONTRACT: _____

_____

EQUIPMENT:_____ DATE INSTALLATION COMPLETE: _____

SERIAL NO.: _____ MAKE & MODEL NO.: _____

PRE-STARTUP	CHECKED BY (Initial)*	DATE	REMARKS
Device/Motor Data:			
- Size (HP/KW)			
- HP FLA			
- MEGGER			
- Rotation			
Other -			
Supply/Starter Data:			
- Fuse Size			
- O/L Size			
- Feeder Size			
Other -			
Control:			
- Interlock Check			
- Local Run			
- Remote Run			
STARTUP Run Under Load			

***** - Indicate [N/A] if not applicable.

DEFICIENCIES NOTED:

NAMEPLATES:

STARTER: _____ **CABLES:** _____

EQUIPMENT: _____

OTHER NOTES:

SIGNATURES FOR EQUIPMENT CHECKOUT COMPLETE AND READY FOR SERVICE		
CONTRACTOR	**OWNER**	**Consultant**
Date:	**Date:**	**Date:**

INSTALLATION CHECKLIST
INSTRUMENTS

P.N. _____ **CONTRACT:** _____ _____ **REF. NO.** _____ **EQUIP. NO.** _____

EQUIPMENT: _____ **DATE INSTALLATION COMPLETE:** _____

SERIAL NO.: _____ **MAKE & MODEL NO.:** _____

PRE-STARTUP	CHECKED BY (Initial)*	DATE	REMARKS
Installation/Mounting Sensor/Transmitter			
Wiring/Conduit Termination and Seal			
Check Fuse Ratings (Supply & Internal)			
Tagging/Nameplate			
Compliance Section 16			
Testing (Ground Loop, Continuity & Installation)			
Power Supply			
Check Instrument Air, Adjust Filter/Regulator			
Check Temperature Control (Internal/Heat Tracing)			
Configure Calibration			
Tailback Lights			
START-UP Verify Operation Under Max. Process Conditions			
Correct Quantities of Expendable Material			
COMMISSIONING Record below the Loop Characteristics which apply to this Instrument			
Manuf./Vendor Inspection Certificate/Letter			
Contacts – Correct Sense on Operation			
Contacts – Correct Status at PLC/RTU			
Analog – Correct Polarity at PLC			
Analog – Correct Polarity with Respect Process			
Analog – Correct Span at Instrument			
Analog – Correct Span at PLC & Display			
Analog – Correct Eng. Units at PLC & Display			

OTHER NOTES:

***** - Indicate [N/A] if not applicable.

SIGNATURES FOR EQUIPMENT CHECKOUT COMPLETE AND READY FOR SERVICE		
CONTRACTOR	**OWNER**	**Consultant**
Date:	**Date:**	**Date:**

INSTALLATION CHECKLIST
PANEL/PLC/COMPUTER

REF. NO. _____

EQUIP. NO. _____

CONTRACT: _____

P.N. _____

EQUIPMENT: _____ **DATE INSTALLATION COMPLETE:** _____

SERIAL NO.: _____ **MAKE & MODEL NO.:** _____

PRE-STARTUP	CHECKED BY (Initial)*	DATE	REMARKS
Installation and Mounting			
Location to Equipment (Electrical Interference)			
Wiring/Conduit Termination and Seals			
Tagging Nameplate			
Compliance Section 16			
Test (Ground Loop, Continuity, Installation)			
Check Fuse/Breaker Ratings			
Communications Test:			
Peer Link			
Remote I/O			
PLC –_PC			
Cable Integrity			
Termination Connectors			
Telephone/Link Modem			
Rack/PLC Switch Settings			
Computer Installation			
Ancillary Equipment Installation			

OTHER NOTES:

***** - Indicate [N/A] if not applicable.

SIGNATURES FOR EQUIPMENT CHECKOUT COMPLETE AND READY FOR SERVICE		
CONTRACTOR	**OWNER**	**Consultant**
Date:	**Date:**	**Date:**

DIVISION 15

MECHANICAL

INDEX

PART 1. GENERAL

1.1 DESCRIPTION

A. Provide basic mechanical materials and requirements as indicated and in compliance with Contract Documents.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. A36/A36M: Standard Specification for Carbon Structural Steel.

2. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.

B. Canadian Standards Association (CSA):

1. C22.2 No. 145 Electric Motors and Generators For Use In Hazardous (Classified) Locations.

2. C390-10: Test Methods, Marking Requirements, and Energy Efficiency Levels for Three-Phase Induction Motors.

3. C747-09: Energy Efficiency Test Methods for Small Motors.

C. Electrical and Electronic Manufacturers Association of Canada (EEMAC).

D. The Institute of Electrical and Electronics Engineers Inc. (IEEE):

1. 112: Standard Test Procedure for Polyphase Induction Motors and Generators.

E. Ontario Regulation 213/91: Occupational Health and Safety Act and Regulations for Construction Projects.

F. Ontario Technical Standards and Safety Authority.

G. Manufacturers' Standardization Society (MSS):

1. SP-58: Pipe Hangers and Supports – Materials and Design.

H. Underwriters Laboratories of Canada (ULC):

1. System No. CUL C-AJ-1106.

2. System No. CUL C-AJ-5125.

3. System No. CUL W-J-1127.

4. System No. CUL C-AJ-1366.

5. CUL C-AJ-8075.

1.3 DEFINITIONS

A. The following are definitions of words found in Mechanical Sections and on associated Drawings:

1. “Concealed” – means work hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.

2. “Exposed” – means work normally visible, including work in equipment rooms and similar spaces.

3. “Provide” (and tenses of “provide”) – means supply and install complete.

4. “Install” (and tenses of “install”) – means install and connect complete.

5. “Supply” – means supply only.

6. "Finished Area" – means any area or part of an area which receives a finish such as paint, or is factory finished.

B. Wherever the words “indicated”, “shown”, “noted”, “listed”, or similar words or phrases are used in the Specification they are understood, unless otherwise defined, to mean that the Product referred to as “indicated”, “shown”, “listed”, or “noted” on the Drawings.

C. Wherever the words “approved”, “satisfactory”, “as directed”, “submit”, “permitted”, “inspected” or similar words or phrases are used in the Specification they are understood, unless otherwise defined, to mean that Work or Product referred to as “approved by”, “inspected by”, etc., the Consultant.

1.4 SUBMITTALS

A. Shop Drawings:

1. It is understood that the following is to be read in conjunction with the wording on the Consultant's Shop Drawing review stamp applied to each and every mechanical work Shop Drawing submitted:

a. "This review is for the sole purpose of ascertaining conformance with the general design concept. This review does not approve the detail design inherent in the Shop Drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the Shop Drawings or of his responsibility for meeting all requirements of the Contract Documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all subtrades."

B. Submit the following Shop Drawings in accordance with Section 01330:

1. Location Drawings (marked-up white prints) for all required sleeves and formed openings in new poured concrete or precast concrete construction.

2. Samples of materials and any other items as specified in succeeding Sections of this Division of the Specification.

3. Submittals as specified in Section 15960.

4. A list of equipment identification nameplates indicating proposed wording and sizes.

5. A list of pipe identification colour coding and wording.

6. A clean "Reviewed" copy of each Shop Drawing for insertion into the Operating and Maintenance Instruction Manual.

1.5 APPLICATION

A. This Section specifies requirements, products, common criteria and characteristics, and methods and execution that are common to one or more Sections of Mechanical Divisions, and it's intended as a supplement to each Section and is to be read accordingly.

1.6 PLANNING AND LAYOUT OF WORK

A. The exact locations and routing of mechanical and electrical services are to be properly planned, coordinated and established with all affected trades prior to installation such that the services will clear each other as well as any obstructions. Generally, give the right-of-way to piping requiring uniform pitch and locate and arrange other services to suit.

B. All shut-off valves, balancing devices, air vents, equipment and similar products, particularly such products located above suspended ceilings, must be located for easy access for servicing and/or removal. Products which do not meet this location requirements are to be relocated at no cost.

1.7 DOCUMENTS

A. The Mechanical Drawings are performance Drawings, Diagrammatic, and show approximate locations for equipment and materials. The Drawings are intended to convey the scope of work and do not necessarily show architectural and structural details. The locations of materials and equipment shown may be altered (when revised layouts have been submitted and approved), to meet requirements of the material and/or equipment, other equipment and systems being installed, and of the building. Provide all fittings, offsets, transformations, and similar items required as a result of obstructions and other architectural or structural details but not shown on the Mechanical Drawings.

1.8 ACCEPTABLE PRODUCT MANUFACTURERS

A. Products scheduled and/or specified on the Drawings and in Sections of Mechanical Divisions of the Specification have been selected to establish a performance and quality standard, and, in some instances, a dimensional standard. In most cases, acceptable Manufacturers are stated for any product specified by Manufacturer's name and model number. The tender price may be based on products supplied by any of the Manufacturers named as acceptable for the particular product. If acceptable Manufacturers are not stated for a particular product, base the tender price on the products supplied by the specified Manufacturers.

B. If products supplied by a Manufacturer named as acceptable are used in lieu of the Manufacturer specified, be responsible for ensuring that the substituted product is equivalent in performance and operating characteristics (including energy consumption if applicable) to the specified product, and, it is to be understood that any additional costs, and changes to associated or adjacent work resulting from provision of products supplied by a Manufacturer other than the specified Manufacturer is included in the tender price. In addition, in equipment spaces where products named as acceptable are used in lieu of specified products and the dimensions of such products differ from the specified products, prepare and submit for review, accurately dimensioned layouts of rooms affected. Prepare and submit for review Shop Drawings, including but not limited to, revised: layouts, sections, elevations, schematics, power supply, wiring diagrams, piping layouts, housekeeping pads, flue/stack layout, ductwork layout, BMS and/or SCADA interface, control components and wiring diagrams, coordinated with all other systems and spaces.

1.9 WORK STANDARDS

A. All Codes and Standards referred to in this Section are the latest edition of the Codes and Standards in effect at the time of tendering this project.

B. All mechanical piping system work, including equipment, must comply in all respects with requirements of the Ontario Technical Standards and Safety Authority, and CSA Standards B51, Boiler, Pressure Vessels and Pressure Piping Code. Where required, fittings, valves, equipment, etc., must bear a CRN number.

C. All electrical items associated with mechanical equipment are to be CSA (or equivalent agency certified electrically) or bear a stamp to indicate special Electrical Safety Authority approval.

1.10 SPARE PARTS

A. Comply with the requirements specified in Section 01630.

1.11 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01400.

1.12 WORKPLACE SAFETY

A. Comply with requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage and disposal of hazardous materials.

B. Comply with all requirements of Ontario Regulation 213/91, and Occupational Health and Safety Act and Regulations for Construction Projects.

1.13 EQUIPMENT AND SYSTEM STARTUP AND COMMISSIONING

A. An independent Commissioning Agent will be retained to supervise system and equipment start-up and performance testing, to test and balance air and water flows, to make final adjustments to equipment and systems, to prepare Operating and Maintenance Instruction Manuals, to update CADD discs for Record Drawings, and to provide other associated services.

B. The work for the independent Commissioning Agent is specified in Section 15960. Carefully read Section 15960 and include for all labour to physically perform start-ups and performance testing, supply of equipment Manufacturer's representatives and technicians on-site, services, etc., which are indicated as being supplied by the Contractor, including:

1. Data and Shop Drawings for Operation and Maintenance Manuals.
2. Marked-up white print "Record Drawings" prepared on site during construction.
3. All test data and certificates.
4. The majority of the Commissioning Work specified in Section 15960 must be complete prior to Substantial Performance of Work.

1.14 DELIVERY STORAGE AND HANDLING

A. Comply with the requirements specified in Section 01800.

PART 2. PRODUCTS

2.1 PIPE SLEEVES

A. Minimum 1.6 mm thick (16 gge) galvanized steel with an integral flange at one end to secure the sleeve to formwork construction.

B. Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.

2.2 SCHEDULE 40 MILD GALVANIZED STEEL PIPE WITH A WELDED-ON SQUARE STEEL ANCHOR AND WATER STOP PLATE AT THE SLEEVE MIDPOINT FIRESTOPPING AND SMOKE SEAL MATERIALS

A. Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with cUL-S115 for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than the fire resistance rating of surrounding construction.

B. Materials are to be compatible with abutting dissimilar materials and finishes.

2.3 WATERPROOFING SEAL MATERIALS

A. Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so that when the bolts are tightened the links expand to seal the opening watertight. The seal assemblies are to be selected to suit the pipe size and the sleeve size or wall opening size. Acceptable products are:

1. Thunderline Corp. (Power Plant Supply Co.) “LINK SEAL” Model S.

2. The Metraflex Co. “MetraSeal” Type ES.

2.4 PIPING HANGERS AND SUPPORTS

A. Pipe hanger and support materials, including accessories, are to be, unless otherwise specified, in accordance with the Manufacturers Standardization Society (MSS) Standard Practice Manual SP-58, “Pipe Hangers and Supports – Materials, Design and Manufacture”, and, where possible, MSS designations are indicted with each product. All hangers shall be zinc plated unless otherwise noted. Hangers and supports for insulated piping are to be sized to fit around the insulation and covering.

B. Horizontal Suspended Piping: Hangers and supports are to be:

1. Adjustable Steel Clevis Hanger Anvil Fig. 260, Taylor Fig. 24, Zinc Plated, HDG & Stainless Steel or approved equivalent – MSS Type 1

2. Adjustable Swivel Ring Band Type Hanger Anvil Fig. 69, Taylor Fig. 41 Swivel Band Hanger, Pre-galvanized and Stainless Steel or approved equivalent – MSS Type 10

C. Horizontal Pipe On Vertical Surfaces: Supports are to be:

1. Steel Offset Pipe Clamp Anvil Fig. 103, Myatt Fig,170, Taylor Fig. 87 Offset Clamp or approved equivalent.

2. Heavy-Duty Steel Pipe Bracket Anvil Fig. 262, Myatt Fig. 161, Taylor Fig. 46 Strap or approved equivalent – MSS Type 26.

3. Single Steel Pipe Hook Myatt Fig. 156, Taylor Fig. 145 or approved equivalent.

D. Vertical Risers Through Floors: Supports are to be:

1. Heavy-Duty Steel Riser Clamp Anvil Fig. 261, Myatt Fig's. 182,183, 190 and 191, Taylor Fig. 82 Std Riser Clamp, & Fig. 82H Heavy Duty or approved equivalent – MSS Type 8.

E. Vertical Piping on Vertical Surfaces: Supports are to be:

1. Heavy-Duty Steel Pipe Bracket or Soil Pipe Bracket Anvil Fig. 262, Myatt Fig. 161, Taylor Fig. 46 Pipe Strap or approved equivalent – MSS Type 26.

2. Extension Split Pipe Clamp Anvil Fig’s. 138R, CT-138R, 128, 128R, and 153, Myatt Fig. 129, Taylor Fig. 38, 38C Hinged Split Ring Hanger & Fig. 38SS Split Ring Hanger Stainless Steel or approved equivalent – MSS Type 12.

F. Special Hangers and Supports: Special hangers and supports for various applications are as follows:

1. For piping in corrosive environments or outdoors – generally as above but hangers and strut located in corrosive areas or outdoors shall be Type 316 Stainless Steel with 316 stainless steel hardware and rods or FRP as specified below. **Zinc plated hardware is not acceptable for outdoor or corrosive use**.

G. Hangers Hardware Located in Corrosive Areas: All hanger hardware shall be FRP or Type 316 Stainless Steel. Zinc plated hangers hardware is not acceptable for corrosive use.

H. Ring stays and/or Bell (Van) Hangers: Are not an acceptable support.

I. Acceptable Manufacturers: Acceptable hanger and support material Manufacturers are:

1. Anvil International.
2. E. Myatt & Co. Inc.
3. Empire Tool & Mfg. Co. Inc.
4. Unistrut.
5. Tolco.
6. Erico Canada.
7. Taylor.

2.5 MECHANICAL WORK IDENTIFICATION MATERIALS

A. Equipment Nameplates: Minimum 1.6 mm (1/16-inch) thick 2-ply laminated coloured plastic plates, white background – black lettering, minimum 12 mm x 50 mm (1/2-inch x 2 inches) for smaller items such as damper motors and control valves, minimum 25 mm x 65 mm (1 inch x 2-1/2 inches) for equipment, and minimum 50 mm x 100 mm (2 inches x 4 inches) for control panels and similar items. Each nameplate is to be complete with bevelled edges and engraved wording to completely identify the equipment with no abbreviations. Wording is generally to be in accordance with the Drawings but must be reviewed prior to engraving. Supply stainless steel screws for securing nameplates in place.

PART 3. EXECUTION

3.1 GENERAL PIPING INSTALLATION REQUIREMENTS

A. Unless otherwise specified, locate and arrange horizontal pipes above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.

B. Neatly group and arrange all exposed work.

C. Make all connections between pipes of different materials using proper approved adapters. Provide cast brass dielectric type adapters at connections between steel and copper pipe.

D. Ensure that equipment and material Manufacturers' installation instructions are followed unless otherwise specified herein or on the Drawings, and unless such instructions contradict governing codes and regulations.

E. Carefully clean all pipe and fittings prior to installation. Temporarily cap or plug ends of pipe, ducts and equipment which are open and exposed during construction.

F. Install piping which are to be insulated so that they have sufficient clearance to permit insulation to be applied continuously and unbroken around the pipe or duct, except at fire barriers, in which case the insulation will be terminated at each side of the fire barrier.

G. Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of your work will constitute acceptance of such surfaces as being satisfactory.

H. Ensure that exposed ferrous metal products, except piping, have at least one factory prime coat, or paint such ferrous metal products with one prime coat on the job.

I. Clean and wire brush ferrous metal products before applying the prime coat. For factory applied finishes, repaint or refinish surfaces damaged during shipment, erection or construction work.

3.2 PIPE JOINT REQUIREMENTS

A. Do not make pipe joints in walls or slabs.

B. Ream all piping ends prior to making joints.

C. Properly cut threads in screwed steel piping and coat male threads, unless otherwise specified, with red lead, Teflon tape or paste, or an equivalent thread lubricant. After the pipe has been screwed into the fitting, valve, union, or piping accessory, not more than two pipe threads are to remain exposed.

D. Site bevel steel pipe to be welded or supply mill bevelled pipe. Remove all scale and oxide from the bevels and leave smooth and clean. Ensure that personnel doing welding work are CWB certified welders and qualified for the particular pressure application worked on, and that all tests required by governing authorities are carried out, including X-ray tests where required for certain applications.

E. Use Bonney Forge Ltd. or approved equivalent welding tees or welding outlet fittings for piping branches off mains, welded or socket type for pipes with welded fittings and threaded type for pipes with screwed fittings. Do not use site fabricated fittings unless approval has been obtained.

F. Unless otherwise specified, make all flanged joints with Garlock Inc. Style 3200 "BLUE-GARD" or approved equivalent gasket materials to suit the application, and suitable bolts and nuts. Bolts are not to be longer than the length necessary to screw the nut up flush to the end of the bolt.

G. Bolts used for flanged connections in all piping with a working pressure of 690 kPa (100 psi) and greater are to be ASTM A193, Grade B-7, with heavy hexagon nuts to ASTM A194, CL-2H or CL 7. Material to be same as pipe.

H. Provide suitable washers between each bolt head and the flange and between each nut and the flange.

I. A random check of bolted flanged connections will be made to verify that flanged connections are properly mated with no shear force acting on bolts. Supply all labour to disconnect and reconnect the selected flanged joints as directed. If improperly mated joints are found, remove and reinstall the affected piping at your expense so that the flanges mate properly. If improperly mated joints are found, additional joints will be checked, and you will be responsible for the repair of any other improper joints discovered.

J. Unless otherwise specified make all soldered joints in copper piping using flux suitable for and compatible with the type of solder being used. Clean the outside of the pipe end and the inside of the fitting, valve, or similar accessory prior to soldering.

K. Install mechanical joint fittings and couplings in accordance with the Manufacturer's instructions.

L. If grooved fittings and couplings are used, ensure that all valves and piping accessories are suitable. Grooves are to be rolled. Make arrangements with the coupling and fitting Manufacturer for shop and/or site instructions and demonstrations as required and adhere to the Manufacturer's instructions with respect to pipe grooving, support, anchoring and guiding the grooved piping system. Note that all grooved end piping system products are to be supplied by a single Manufacturer who is operating to an ISO 9001 Program.

3.3 INSTALLATION OF PIPE SLEEVES

A. Where pipes pass through concrete and/or masonry surfaces provide pipe sleeves as follows:

1. In poured concrete slabs, unless otherwise specified – minimum 1.6 mm thick (16 gge) flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves.

2. In concrete or masonry walls – Schedule 40 galvanized steel pipe.

B. Sleeves in waterproofed slabs are to be lengths of Schedule 40 mild galvanized steel pipe in accordance with the Drawing detail. Provide waterproof sleeves in the following locations:

1. In all floors equipped with waterproof membranes.

C. Size sleeves, unless otherwise specified, to leave 12 mm (1/2-inch) clearance around the pipes, or where pipe is insulated, a 12 mm (1/2-inch) clearance around the pipe insulation.

D. Pack and seal the void between the pipe sleeves and the pipe or pipe insulation for the length of the sleeves as follows:

1. Pack sleeves in fire rated construction as specified in the article entitled "INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS".

2. Pack sleeves in non-fire rated interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound.

3. Pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified.

4. Seal sleeves in exterior walls (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.

E. Terminate sleeves for piping which will be exposed so that the sleeve is flush at both ends with the wall, partition or slab surface so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to extend 100 mm (4 inches) above the finished surface.

F. "Gang" type sleeving will not be permitted.

3.4 INSTALLATION OF WATERPROOFING SEAL MATERIALS

A. Provide watertight link type mechanical seals in exterior wall openings where shown and/or specified.

B. Assemble and install each mechanical seal in accordance with the Manufacturer's instructions.

C. Periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.

3.5 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIAL

A. Where mechanical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal material installed in accordance with ULC Firestop System requirements to seal holes and voids in the walls or slabs, as follows:

1. Bare pipe or conduit through a floor with a circular sleeved or core drilled opening – System No. CUL C-AJ-1366.

2. Bare pipe or conduit through a floor with a rectangular cast or cut opening – System No. CUL C-AJ-1066.

3. Bare pipe or conduit through a wall with a circular sleeved or core drilled opening – System No. CUL W-J-1127.

4. Bare pipe or conduit through a wall with a rectangular cast or cut opening – System No. CUL C-AJ-1106.

5. Insulated pipe through a wall with a sleeved or core drilled circular opening – System No. CUL C-AJ-5125.

6. Insulated pipe through a wall with a rectangular cast or cut opening – System No. CUL C-AJ-8075.

7. Insulated pipe through a floor with a circular sleeved or core drilled opening – System No. CUL C-AJ-5125.

8. Insulated pipe through a floor with a rectangular cast or cut opening – System No. CUL C-AJ-8075.

3.6 INSTALLATION OF PIPE HANGERS AND SUPPORTS

A. Provide all required pipe hangers and supports. Provide any additional structural steel channels, angles, inserts, beam champs and similar accessories required for hanging or supporting pipe. Unless otherwise shown or specified, hang or support pipes from the structure only.

B. For insulated pipe, size the hanger support to suit the insulated pipe and install the hanger or support on the outside of the insulation and covering.

C. Underground Piping: Support requirements for underground piping are as follows:

1. Support underground pipe, unless otherwise specified, on a well tamped bed of dry, natural, undisturbed earth free from rocks or protrusions of any kind, or on compacted material as specified.

2. Ensure that all bedding and supports for underground pipes are flat and true and that allowances are made for pipe hubs, couplings, or other protrusions so that no voids are left between the pipe and the bedding.

3.7 MECHANICAL WORK IDENTIFICATION

A. Equipment: Provide an identification nameplate for each piece of equipment, including items such as control valves, motorized dampers, instruments, and similar products. Secure nameplates in place with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces. Locate all nameplates in the most conspicuous and readable location.

B. Electrical Tracing: For all electrically traced mechanical work, identification wording is to include “ELECTRICALLY TRACED”.

3.8 DISCONNECTION AND REMOVAL OF EXISTING MECHANICAL WORK

A. Where indicated on the Drawings, disconnect and remove existing mechanical work. Disconnect at the point of supply, remove obsolete connecting services and make the system safe. Cut back obsolete piping behind finishes and cap water-tight unless otherwise specified.

B. Where existing mechanical services pass through or are in an area to serve items which are to remain, maintain the services in operation. Include for rerouting existing services concealed behind existing finishes and which become exposed during the renovation work, so as to be concealed behind new or existing finishes.

C. Unless otherwise specified, remove from the site and dispose of all existing materials which have been removed and are not to be relocated or reused.

3.9 EQUIPMENT BASES AND SUPPORTS

A. Unless otherwise specified, set all floor mounted equipment on 100 mm (4 inch) high concrete housekeeping pads 100 mm (4 inch) wider and longer than the equipment base dimensions.

B. Supply Dimensioned Drawings, equipment base templates and anchor bolts for proper setting and securing of equipment on pads, and be responsible for all required leveling, alignment, and grouting of the equipment.

C. For equipment not designed for base mounting, where required, provide prime coat painted structural steel stands flange bolted to housekeeping pads.

D. Provide prime coat painted structural black steel angle or channel frames and brackets for all surface wall mounted equipment not specifically designed for surface wall mounting, unless otherwise specified.

3.10 CONCRETE WORK FOR MECHANICAL SERVICES

A. Provide all concrete work, including reinforcing and formwork required for mechanical work.

B. All concrete work is to be in accordance with requirements of Division 3 unless otherwise specified.

3.11 EXCAVATION AND BACKFILL WORK

A. Do all excavation, backfill and related work required for your work. Perform such work in accordance with requirements of Division 2, except as modified by this Article. Obtain a copy of the soil test report.

B. Grade the bottom of trench excavations as required.

C. In firm, undisturbed soil, lay pipes directly on the soil.

D. In rock and shale, excavate to 150 mm (6 inches) below and a minimum of 200 mm (8 inches) to either side of the pipe, and backfill to the required invert with compacted Granular "A" material.

E. Prepare new bedding under the pipe in unstable soil, in fill, and in all cases where pipe bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins. Compact to maximum possible density and support the pipe by 200 mm (8 inches) thick concrete cradles spanning full length between firm supports. Install reinforcing steel in the cradles or construct piers every 2.4 m (8 feet) or closer, down to solid load bearing strata. Provide a minimum of one pier per length of pipe. Use the same method where pipes cross.

F. Where excavation is necessary in proximity to and below the level of any footing, backfill with 13,800 kPa (2000 psi) concrete to the level of the highest adjacent footing.

G. Provide support over at least the bottom one-third segment of the pipe in all bedding methods, shape the excavation to fit pipe hubs, couplings, and similar items and ensure even bearing along the barrels.

H. Backfill trenches within the building with clean sharp sand in individual layers of maximum 150 mm (6 inch) thickness compacted to a density of 100 percent Standard Proctor. Hand compacts the first layers up to a compacted level of minimum 300 mm (12 inches) above the top of the pipe. Hand or machine compact the balance up to grade.

I. Backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18 inches) thick above the pipe, hand compacted to a density of 95 percent Standard Proctor, using Granular "A" gravel. Backfill the balance in 150 mm (6 inch) layers with approved excavated material, compacted to 95 percent Standard Proctor density.

J. Backfill trenches outside the building under roads, parking lots or traffic areas with crushed stone or Granular "A" gravel in layers not exceeding 150 mm (6 inch) thickness, compacted to 100 percent Standard Proctor density up to grade level.

K. Do not use water for consolidation or during compaction of backfill.

L. Fill all backfill depressions to correct grade level with appropriate material and maximum compaction after an adequate period has passed to reveal any settlement and pay all costs to make good damages caused by settlement.

M. Dispose of surplus excavated materials as specified in Division 2.

N. Do pumping as required to keep excavations free of water.

O. The location and inverts of existing underground site services shown on the Drawings are based on available information and are assumed to be correct, however, prior to excavation, carefully check inverts and locations and report any serious discrepancy and contact utilities to accurately locate their services.

P. You will be held responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.

Q. Ensure that all underground piping subject to freezing and located inside or outside the building has a minimum of 1.37 m (4 feet-6 inches) of cover.

R. After the first lift of backfill has been compacted, mark the entire path of pipe using continuous 75 mm (3 inches) wide detectable identified marking tape SMS Ltd. D-UGMT or approved equivalent.

3.12 CUTTING AND PATCHING FOR MECHANICAL WORK

A. Do all cutting and patching of the existing building for the installation of your work. Perform all cutting in a neat and true fashion, with proper tools and equipment. Patch surfaces, where required, to exactly match existing finishes using tradesmen skilled in the particular trade or application worked on.

B. Where new pipes pass through existing construction, core drill an opening.
Size openings to leave 12 mm (1/2-inch) clearance around the pipes or pipe insulation.

C. Prior to drilling or cutting an opening, determine the location, if any, of existing services concealed in the construction to be drilled or cut. X-ray the walls or slabs if required.

D. You will be responsible for the repair of any damage to existing services, exposed or concealed, caused as a result of your cutting or drilling work.

E. Note that where drilling is required in waterproof slabs, size the opening to permit snug and tight installation of a pipe sleeve which is sized to leave 12 mm (1/2-inch) clearance around the pipe or pipe insulation. Provide a pipe sleeve in the opening. Pipe sleeves are to be Schedule 40 galvanized steel pipe with a flange at one end and a length to extend 100 mm (4 inches) above the slab. Secure the flange to the underside of the slab and caulk the void between the sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water-tight installation.

3.13 PACKING AND SEALING CORE DRILLED PIPE OPENINGS

A. Pack and seal the void between the pipe opening and the pipe or pipe insulation for the length of the opening as follows:

1. Pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal.

2. Pack and seal openings in fire rated walls and slabs as specified in this Section.

3. Pack and seal openings in exterior walls with mechanical link type waterproofing seal materials specified in Part 2 of this Section.

3.14 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01800.

END OF SECTION

PART 1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Basic Mechanical Materials, Methods and Requirements – Section 15050.

B. Potable and Non-Potable Water Piping Systems – Section 15140.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM):

1. B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

2. C165: Standard Test Method for Measuring Compressive Properties of Thermal Insulations.

3. C177: Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

4. C335: Standard Test Method for Steady-State Heat Transfer Properties of Pipe Insulation.

5. C449/C449M: Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

6. C518: Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

7. E96: Standard Test Methods for Water Vapor Transmission of Materials.

B. National Fire Protection Association (NFPA):

1. 255: Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories of Canada (ULC):

1. S102: Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.3 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for all products specified in Part 2 of this Section.

PART 2. PRODUCTS

2.1 FIRE HAZARD RATINGS

A. All insulation materials are to meet requirements of CAN/ULC-S700 Series Standards.

B. Unless otherwise specified, all insulation system materials inside the building must have a fire hazard rating of not more than 25 for flame spread and 50 for smoke developed when tested in accordance with CAN/ULC-S102.

2.2 PIPE INSULATION MATERIALS

A. Closed Cell Foamed Glass: Pittsburgh Corning "FOAMGLASS", Expanded, Sectional, Rigid Sleeve Type Insulation with a Liquid or Vapour Permeability Rating (as per ASTM C240) of 0.00, and a factory applied "PITTWRAP SSII" Self-Sealing Jacket secured with, when required. "PITTWRAP SS" Primer and PC88 Adhesive, or Belform Insulation Ltd. ZES "FOAMGLASS", Expanded, Sectional Rigid Pipe Insulation (as per ASTM C552) and a factory applied SubSeal Self Sealing Jacket.

B. Premoulded Fibre Glass: Rigid, Sectional, Sleeve Type Insulation with a "K" Factor of 0.033W/m degrees C at 24 degrees C mean (0.23 Btu-in/hr ft^2 degrees F at 75 degrees F mean 0.23 at 75 degrees F) when tested in accordance with per ASTM C335 (Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation), and a factory applied Vapour Retarding Jacket (.02 perm). Acceptable products are:

1. Johns Manville "Micro-Lok H" with "ASJ-SSL Jacket.
2. Knauf Insulation Earthwool 1000° with ASJ/SSL Pipe Insulation.
3. Manson Insulation Products Ltd. "ALLEY K" with "ASJ-SSL" Jacket.

C. Phenolic Foam: Belform Insulation Ltd. (519-652-5190) "Insulphen" rigid, 32 kg/m^3 (2 lb/ft^3) density, closed cell sectional pipe insulation and factory fabricated shapes for fittings, with a R Value of 7.7 for 25 mm (1 inch) thick insulation and a factory applied FSK Vapour Barrier Jacket.

2.3 INSULATION FASTENINGS

A. Tape Sealant: Venture Tape Corp. 1525CW, 3M FSK Silver (foil) Facing Tape UL 723 classified (5/10 flame/smoke rating), 3M™ FSK Facing Tape or approved equivalent self-adhesive insulation tapes, Types PAF, FSK, ASJ, or SWV as required to match the surface being sealed.

2.4 INSULATION JACKETS AND FINISHES

A. Aluminum: Smooth aluminum jacket material with a 13 mm (1/2-inch) safety edge to ASTM B209, 0.6 mm (0.025 inch) thick, factory cut to size and complete with moisture barrier and 50 mm overlap and with stainless steel bands on 300 mm (12 inch) centers. Fittings are to be two piece epoxy coated with silicone joints as required.

B. Adhesive Backed Metal Faced Weather Barrier: Belform Insulation Ltd. "Flex-Clad 400" inch sheet material with an adhesive backing and an embossed aluminum facing for above ground application and a black SubSeal for below grade application.

C. Factory Applied Insulation Weather Barrier: Knauf Insulation Redi-Klad™ 1,000°pipe insulation, factory applied, five-ply, weather and abuse resistant, 0.0 permeability, embossed aluminum, self-sealing lap pipe insulation jacket. Insulation and jacketing system shall be designed for piping systems operating from -18 degrees C to 538 degrees C (0 degrees F to 1,000 degrees F).

PART 3. EXECUTION

3.1 GENERAL INSULATION APPLICATION REQUIREMENTS

A. Unless otherwise specified, do not insulate the following:

1. Factory insulated equipment and piping.

2. Manufactured expansion joints and flexible connections.

B. Install insulation directly over pipes and not over hangers and supports. Insulation and covering is to pass unbroken through the hangers and supports.

C. Do not apply insulation unless leakage tests have been satisfactorily completed.

D. Ensure that all surfaces to be insulated are clean and dry.

E. Ensure that the ambient temperature is minimum 13 degrees C (55 degrees F) for at least one day prior to the application of insulation, and for the duration of insulation work, and that relative humidity is and will be at a level such that mildew will not form on insulation materials.

F. Install piping insulation and covering continuous through pipe openings and sleeves.

G. Pipe insulation at hangers and supports is to consists of minimum 300 mm (12 inch) long sections of calcium silicate or phenolic foam sectional insulation with vapour barrier jacket and 300 mm (12 inch) long galvanized steel shields between the insulation covering and the hanger or support for all pipe 50 mm (2 inch) dia. and above and not requiring a roller hanger or support. Provide "Armafix" Insulation Pipe Hangers (IPH) for flexible foam elastomeric insulation.

H. When insulating "cold" piping and equipment, extend insulation up valve bodies and other such projections as far as possible, and protect the insulation jacketing from the action of condensation at its junction with the metal. Insulation on cold piping must not be broken. Do not use saddles only shields are acceptable on cold piping.

I. The final appearance and finish of exposed mechanical work depends to a large degree on the quality of the insulation application; therefore, a neat and properly finished insulation job will be insisted upon.

J. Where piping and/or equipment is traced with electric heating cable, ensure that the cable has been tested and accepted prior to the application of insulation, and ensure that the cable is not damaged or displaced during the application of insulation.

K. Where existing insulation work is damaged as a result of a new mechanical work, repair the damaged insulation work to new work standards.

L. Where Inorganic Fibre Glass Rigid Sleeve Type Insulation is terminated at valves, equipment, unions, etc., neatly cover the exposed end of the insulation with a purpose made PVC cover on "cold" piping, and with canvas jacket on "hot" piping.

M. Carefully and neatly gouge out insulation for proper fit where there is interference between weld bead, mechanical joints, etc., and insulation. Bevel away from studs and nuts to permit their removal without damage to insulation, and closely and neatly trim around extending parts of pipe saddles.

N. Where thermometers, gauges, etc., occur in insulated piping, and where access to heat transfer piping balancing valve ports and similar items are required, create a neat, properly sized hole in the insulation and provide a suitable grommet in the opening.

3.2 PIPE INSULATION REQUIREMENTS – INORGANIC FIBRE GLASS

A. Insulate the following pipe with Inorganic Fibre Glass Insulation of the thickness noted:

1. Potable cold water piping up to and including 32 mm (1-1/4 inch) inside building and above ground – 25 mm (1 inch) thick.

2. Potable cold water piping 40 mm (1-1/2 inch) and larger inside building and above ground – 40 mm (1-1/2 inch) thick.

3. Non-potable cold up to and including 32 mm (1-1/4 inch) inside building and above ground – 25 mm (1 inch) thick.

4. Non-potable cold water piping 40 mm (1-1/2 inch) and larger inside building and above ground – 40 mm (1-1/2 inch) thick.

5. All piping located outside building or inside building in unheated areas and indicated to be traced with electric heating cable – 50 mm (2 inch) thick.

B. Piping: Ensure that the overlap flap of the sectional insulation jacket is secured tightly in place. Cover section to section butt joints with tape sealant.

C. Fittings: Insulate fittings with sectional pipe insulation mitred to fit tightly, and cover butt joints with tape sealant, or, alternatively, wrap fittings with blanket mineral fibre insulation to a thickness and insulating value equal to the sectional insulation and secured in place with adhesive and/or wire and covered with fitting covers. Provide sufficient material to prevent the cover from being pushed in or crushed.

D. "Cold" Piping Valves, Strainers, etc.: Insulate valves, strainers, and similar piping system accessories in "cold" piping such as potable water piping with cut and tightly fitted segments of sectional pipe insulation with all joints covered with tape sealant, or, alternatively, wrap the piping valve, strainer, etc., with blanket Inorganic Fibre Glass and cover with covers as for "Fittings" above.

E. Flanges and Mechanical Couplings: Terminate sectional insulation approximately 50 mm from the flange or coupling on each side of the flange or coupling. Cover the flange or coupling with a minimum 50 mm (2 inch) thickness of blanket Inorganic Fibre Glass Insulation wide enough to butt tightly to the ends of the adjacent sectional insulation. Secure the blanket insulation in place and cover with a cover. Provide sufficient material to prevent the cover from being pushed in or crushed.

F. Alternative Phenolic Foam Insulation: Phenolic foam insulation with a thickness to give an equivalent insulating value to that of the Inorganic Fibre Glass Insulation and secured in place and sealed in accordance with the Manufacturer's recommendations is acceptable in lieu of Inorganic Fibre Glass Insulation.

3.3 PIPE INSULATION REQUIREMENTS – CLOSED CELL FOAMED GLASS

A. Install closed cell foamed glass insulation in strict accordance with the Manufacturer's published instructions to suit the application, and using adhesive, joint sealants, and jacketing to produce a 100 percent water-tight installation. Insulate the following pipe with closed cell foamed glass of the thickness noted:

1. Electrically heat traced piping outdoors.

2. All outdoors piping required to be insulated.

3.4 INSULATION FINISH REQUIREMENTS

A. Aluminum: Install aluminum jacket material tightly in place with overlapped circumferential joints positioned to shed water and covered with butt straps supplied with the jacket.

3.5 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01800.

END OF SECTION

PART 1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Basic Mechanical Materials, Methods and Requirements – Section 15050.

B. Electric Power Wiring Connections to Equipment – Division 16.

1.2 REFERENCES:

A. American Society for Testing and Materials International (ASTM):

1. A743: Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.

2. B88: Standard Specification for Seamless Copper Water Tube.

B. American Water Works Association (AWWA):

1. B-300: Hypochlorites.

C. Canadian Standards Association (CSA):

1. B64: Backflow Preventers and Vacuum Breakers.

2. ANSI/NSF-61 and ASME A112.18.1/CSA B125.1-2012, NSF-372.

D. Lead Free Requirements:

1. US Safe Drinking Water Act Section 1417.

1.3 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for all products specified in Part 2 of this Section except for pipe and fittings and chlorine.

B. Test Data: Submit the following test data prior to application for Substantial Performance:

1. Leakage test sheets as per Section 15050.

2. Water purity test results indicating chlorine residual.

PART 2. PRODUCTS

2.1 ALL PRODUCTS SHALL NOT BE BRONZE, BRASS OR COPPER, UNLESS OTHERWISE NOTED.

2.2 PIPE, FITTINGS AND JOINTS

A. Ductile Iron: Centrifugally cast cement lined ductile iron to ANSI A216 and AWWA C-106, complete with a protective coating of bituminous paint, standard cement lined cast iron mechanical joint fittings painted as for pipe, and mechanical joints to CAN/CSA B131.1 with electric conductivity strips to bridge joints.

B. Soft Copper: Type "K" Soft Copper to ASTM B88, supplied in a continuous coil with no joints if possible, and complete with, if joints are required, compression type flared joint couplings.

C. Stainless Steel Pipe:

1. Stainless steel piping systems shall be fabricated from 316L Stainless Steel, minimum Schedule 10, unless otherwise required to satisfy design working pressure 690Kpa (100 psi) requirement and support spacing.

2. The stainless steel piping system including tees, elbows, lateral fittings, flanges, specials and couplings, etc., shall be designed and reinforced for the operating pressure 551 kPa (80 psi) of and surge pressures of 862 kPa (125 psi).

3. The stainless steel pipe and fittings shall be manufactured from Type 316L Stainless Steel produced from parent metal conforming to ASTM-A240 and AWWA Manual M11 and reinforced as required.

4. Manufacturer shall provide the Contract Administrator with a chemical analysis confirming material grade with each batch of stainless steel piping.

5. The pipe shall be carefully die-formed or rolled true to dimension and round within a tolerance plus or minus 1.5 mm. Ends of the pipe and fittings are to be perpendicular to the longitudinal axis. All joints shall be welded by either Tungsten Inert Gas or Metal Inert Gas Method.

6. Pipe surfaces shall be smooth and even and the interior weld bead shall not be higher than 1.5 mm.

7. The pipes shall be pickled by immersion in acid bath for removal of weld discoloration and iron pick-up. After pickling, the pipe and fittings shall be thoroughly washed with fresh clean water. All pipes shall be properly secured for shipment and marked in the shop for identification at job site. The exterior finish of the pipework shall be in accordance with the Manufacturer's recommendation unless otherwise noted herein.

8. Joints shall be welded or flanged end unless otherwise noted on the Drawings.

9. After the piping system has been installed and tested the Contractor shall pickle wash the stainless steel piping system to remove weld discoloration and iron pick-up. After pickling, the pipe and fittings shall be thoroughly washed with fresh clean water and inspected by the Contract Administrator. If deemed necessary by the Contract Administrator, the Contractor may be instructed to repeat the entire pickle wash procedure.

10. After successful testing of the piping system the Contractor shall drain the piping and blow warm air through the piping system to ensure all water droplets have been removed to prevent premature corrosion.

11. Scheduled of stainless steel pipework and fittings shall be as noted on the following table:

SCHEDULE OF STAINLESS STEEL PIPEWORK AND FITTINGS			
Item	**Size Range (mm)**	**Manufacturers Standard Gauge for Sheet Steels**	**Description**
Flanges	38 to 300 350 or greater	SCH. 10	Rolled Van Stones, or stub end type, or Victaulic.
Gasket	All Sizes		Full face EPDM and certified to NSF/ANSI 61 – Drinking Water System Components. Gaskets shall be Garlock Series 98206, or Contract Administrator Approved Equal. When connecting to existing flange/blind flange, new proper gasket shall be used.
Studs, Nuts, Bolts and Washers	All Sizes		Studs bolts and washers shall be best quality Type 316 Stainless Steel heavy hex bolts complete with hex nuts. Contractor shall use anti-seize lubricant on all stainless steel bolts. Lubricants used for nuts and bolts located in the reservoir or in contact with portable water shall be NSF/ANSI 61 approved. When connecting to existing flange/blind flange, new 316 Stainless Steel bolts and nuts shall be used.

SCHEDULE OF STAINLESS STEEL PIPEWORK AND FITTINGS			
Item	**Size Range (mm)**	**Manufacturers Standard Gauge for Sheet Steels**	**Description**
Flanges	40 to 350	Equal wall to pipe wall of same size	Pressed neck type – butt welded.
	400 or greater	Equal wall to pipe wall of same size	Rolled angle type.
Elbows	40 to 900	Equal wall to pipe wall of same size	Smooth flow or fabricated mitred type – butt welded or Victaulic.
Tees, Crosses, Reducers	40 to 900	Equal wall to pipe wall of same size	Fabricated type – butt welded or Victaulic.

D. Stainless Steel Tubing

1. Stainless steel tubing shall be used for all water piping, less than or equal to 50 mm in diameter unless otherwise shown on the Drawings.

2. Stainless steel tubing shall be fully annealed Type 316 Seamless Hydraulic Tubing to ASTM A-269, A213 or equivalent. Hardness shall be Rb80 or less. Tubing to be free of scratches and suitable for bending and flaring. Joints shall be made with Swagelock stainless steel compression fittings or Contract Administrator approved equivalent as supplied by Avon Valve and Fitting Limited, Scarborough. Fittings must withstand a working pressure of 1034kPa without leakage.

2.3 SHUT-OFF VALVES

A. Stainless Steel Ball Valves: Type 316 Stainless Steel ball, stem and packing unit, Durafill Seats, Type 304 Stainless Steel Handle (lockable), NPT ends for valves 75 mm or smaller, and flanged ends for valves 100 mm and above.

1. Where piping is insulated provide stem extensions to clear insulation.

2. Acceptable Suppliers:

   a. Contromatics/Watts.

   b. Worchester.

   c. Jamesbury.

   d. Bray Flow-Tek Series.

   e. Trueline.

2.4 BACKFLOW PREVENTERS

A. Lead free Reduced Pressure Detector Assembly backflow preventers in accordance with CSA-B64, complete with inlet strainer, inlet and outlet shut-off valves, an intermediate relief valve, ball valve type test cocks, and a proper air gap fitting. System to be provided with Valve Setter for connection with underground piping in lieu of concrete thrust blocks.

B. Backflow preventer to be installed inside of assembly enclosure, described in the Section 15140-1.

1. Acceptable Products are:

a. Watts Water Technologies LF909QT-S-AG Series for 20 mm (3/4") to 50 mm (2”) size.

b. Zurn/Wilkins 375-SAG Series for 20 mm (3/4") to 50 mm (2") size.

c. Apollo/Conbraco Industries Inc. Series 40-200 for 20 mm (3/4") to 50 mm (2").

2.5 VACUUM BREAKERS

A. Threaded brass or bronze lead free 20 mm (3/4-inch) diameter hose connection vacuum breakers to CSA-B64, each designed to connect to the hose bibb inlet and to be non-removable when in place.

B. Acceptable Products are:

1. Zurn, Model BFP-8F.

2. Watts Water Technologies (Canada) Inc. LF8.

3. or approved equivalent.

2.6 CHLORINE

A. Javex Manufacturing Canada “JAVEX-12” or approved equivalent sodium hypochlorite to AWWA B-300-75.

PART 3. EXECUTION

A. All products shall not be bronze, brass or copper, unless otherwise noted.

3.1 PIPING INSTALLATION REQUIREMENTS

A. Provide all required potable water piping.

B. Piping, unless otherwise specified, is to be as follows:

1. For underground piping less than 100 mm (4 inch) diameter to points 1500 mm (5 feet) outside the building lines – Type “K” Soft Copper.

2. For all underground ductile iron pipe provide Polyethylene Film: ANSI/AWWA C105/A21.5 with minimum nominal thickness of 200 microns and minus tolerance with 10 percent. Provide tubes for straight pipe and sheets for fittings or tees. Securing Tape: Thermoplastic material with minimum thickness 200 microns, width 25 mm, and pressure sensitive adhesive face capable of bonding to metal, bituminous coating and polyethylene.

3. For pipe inside building and above ground –Type 316L Stainless Steel with joints and gasket material suitable for potable water.

C. Brace and secure underground water service pipe at bends, tees and similar fittings with concrete thrust blocks in accordance with Municipal or OPSS Standards and Details.

D. Tracer Wire for PVC U/G Pipe: Prior to backfilling, secure light-coloured plastic insulated #14 gge TW solid copper wire to the top of all buried PVC pipe secured to the top of the pipe with plastic type ties for the entire length of the pipe for pipe location tracing purposes. Terminate in a round or square non-metallic PVC floor box, flush mounted with a brass cover plate. Coil 450 mm (18") of wire inside box.

E. Lay pipes true to line and grade with bells upgrade. Fit sections together so that, when complete, the pipe has a smooth and uniform invert. Keep pipe thoroughly clean so that jointed compound will adhere. Inspect the pipe for defects before being lowered into the trench. Do not use defective pipe.

F. Slope all piping so that it can be completely drained.

G. Provide proper dielectric unions in all connections between copper pipe and ferrous pipe or equipment. Dielectric fitting to conform to ASTM F492 complete with thermoplastic liner.

3.2 INSTALLATION OF SHUT-OFF VALVES

A. Provide shut off valves on each branch to each piece of equipment, fixtures and wherever else indicated on Drawings.

3.3 INSTALLATION OF DRAIN VALVES

A. Provide a drain valve at the bottom of potable water piping risers and at all other piping low points.

B. Locate drain valves so that they are easily accessible.

3.4 INSTALLATION OF HOSE BIBBS

A. Provide hose bibs where shown and/or specified on the Drawings.

B. Unless otherwise shown, specified or required, mount hose bibs approximately 915 mm (3 feet) above the floor. Confirm exact locations prior to roughing-in.

3.5 INSTALLATION OF BACKFLOW PREVENTERS

A. Provide a backflow preventer in each direct potable cold water connection to equipment other than plumbing fixtures and fittings, refer to Drawings.

B. Locate each backflow preventer in outdoor assembly enclosure such that it is easily accessible for maintenance and testing. Equip each backflow preventer with an air gap fitting and pipe the reduced pressure zone water outlet to drain.

C. Test backflow preventer in accordance with CSA-B64.

3.6 INSTALLATION OF VACUUM BREAKERS

A. Provide a vacuum breaker for each potable water hose bibb that is not factory equipped with a vacuum preventer.

3.7 FLUSHING AND DISINFECTING PIPING

A. Flush and disinfect potable water piping after leakage testing is complete.

B. Flush piping with a sufficient flow of potable water to produce a velocity of 1.5 mps (5 fps) for 10 minutes, or until all foreign materials have been removed and the flushed water is clear. Provide connections and pumps as required. Open and close valves, faucets, hose outlets, and service connections to ensure thorough flushing.

C. Dissolve chlorinous compounds such as “PITTCHLOR” or “HTH” in water to produce a solution.

D. Introduce the solution at one end of the system being sterilized until water taken off at the remote end(s) test at a level of 50 mg/litre.

E. Allow the chlorinous solution to remain in the piping for 24 hours. Take further samples and test them to ensure there are not less than 25 mg/litre of chlorine residual throughout the system. If less than 25 mg/litre of chlorine residual exist in the system after 24 hours reflush the entire system and repeat the sterilization procedure. Do not place piping into service until bacteriological tests indicate zero coliform count.

F. Provide copies of test results.

G. When disinfecting is complete, fill the systems.

3.8 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01800.

END OF SECTION

PART 1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Basic Mechanical Materials, Methods and Requirements – Section 15050.

B. Potable and Non-Potable Water Piping Systems – Section 15140.

C. Electric Power Wiring Connections to Equipment – Division 16.

1.2 REFERENCES:

A. American Society for Testing and Materials International (ASTM):

1. ASTM B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. American Society of Sanitary Engineering (ASSE):

1. ASSE-1060: Performance Requirements for Outdoor Enclosures for Backflow Prevention Assemblies.

C. Canadian Standards Association (CSA):

1. B64: Backflow Preventers and Vacuum Breakers.

1.3 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for all products specified in Part 2 of this Section.

PART 2. PRODUCTS

2.1 PRODUCT SELECTION

A. All Backflow Prevention Assembly Enclosures shall be ASSE Certified for compliance with ASSE-1060 and CSA-B64.

B. Base of Design: Sized for 32 mm (1-1/4”) Reduced Pressure Principle Assembly.

1. Manufacturer: Safe-T-Cover, Model: 200SN-AL, Inside Clear Dimensions: 483 mm W x 1168 mm L x 965 mm H (19"W x 46"L x 38"H).

C. Acceptable Manufacturers:

1. Apollo valves/Conbraco Industries.
2. Watts Regulator Company.
3. G & C Enclosures.
4. AquaSHIELD Enclosures LLC.
5. Equal approved.

2.2 MATERIALS OF FABRICATION

A. Material of fabrication shall be 5052-H32 marine grade aluminum (.050/18 gauge), mill finish and shall meet ASTM B209.

B. Insulation shall be 40 mm (1.5 in) (9.0 "R" value) minimum thickness polyisocyanurate foam laminated to a glass fiber reinforced facer (each side). The insulation shall have the following properties:

1. Dimensional Stability-Less than 2% Linear Change, ASTM D-2126.
2. Compressive Strength-138kPa (20PSI), ASTM D-1621.
3. Water Absorption-Less than 1% by Volume, ASTM C-209.
4. Moisture Vapor Transmission-Less than one (1) Perm, ASTM E-96.
5. Product Density-Nominal 32.0 kg per Cubic Meter (2.0 lbs. per cubic foot), ASTM D-1622.

6. Flame Spread=25, ASTM E-84.

7. Service Temperature = -73.3°C (-100°F) to +121.1°C (+250°F) Maximum.

8. The insulation shall be of uniform thickness.

2.3 ROOF, WALLS & PANELS

A. The roof, walls and panels of the enclosure shall be constructed of 5052-H32 (.050/18 gauge) marine grade aluminum, mill finish, ASTM B209 outside with insulation 40 mm (1-1/2 in) (9.0 "R" value) thick in the walls and panels and 75 mm (3") (18.0 "R" value) thick in the roof.

B. The enclosure shall have a completely removable key locking front access panel (door).

C. Roof will be hinged with a full-length stainless steel piano hinge and secured in the closed position with interior latches.

D. The aluminum, insulation and structural members shall be securely bonded together to form a composite panel.

E. The aluminum panels shall be provided with a PVC or similar exterior film to prevent damage before installation. The film shall be removed before installation.

F. The complete assembly, including valve stems, shall be protected by being inside the enclosure.

G. All screws shall attach to structural members.

H. The walls of the enclosure shall be securely attached to the concrete base with inside anchoring brackets.

I. Access panels shall be completely removable.

J. Access panels shall be provided with built-in pad lockable folding T-handles.

K. Clear opening drain panel area shall be 946 mm W x 150 mm H (37 1/4"W x 5 7/8"H).

L. Drain panel shall have a stainless steel hinge and a stainless steel light strength spring as a positive means of closure so that the drain panel will not be activated by wind.

M. The drain flap shall be constructed of the same materials that is used in the walls and roof of the enclosure.

N. Drain panel shall be designed to remain closed except during water discharge.

2.4 HEATING EQUIPMENT (ASSE 1060 CLASS I ENCLOSURE)

A. Heater shall be ETL, UL, or CSA certified and meet ASSE Standard 1060 Class 1 for use as freeze protection.

B. Electrical power source for heater shall be a designated circuit with GFI protection and a minimum of 200 mm (8") clearance from receptacle base to top of slab.

C. Heating equipment shall be furnished and designed by the Manufacturer of the enclosure to maintain an interior temperature of +4.4°C (+40°F) with an outside temperature of -34.4°C (-30°F).

D. The heating element shall be in a form of water-tight, 120 Volt, self-regulating plug-in heat cable, capable to provide 90 Watts of heat (5 Watt/foot thermal output).

E. The heat cable to be minimum 5.5m (18 feet) long and shall plug into a GFI receptacle. The base design is Safe-T-Cover (Chromalox) Heat Cable #30.

F. The heater shall be provided with a thermostat adjustable from +4.4°C (+40°F) to +37.8°C (+100°F). The thermostat, all conduit and wiring fittings provided shall be suitable for “water-tight” installation.

2.5 MOUNTING HARDWARE

A. Mounting hardware shall be furnished and shall be 300 series stainless steel and/or 5052-H32 aluminum.

B. All threaded fasteners shall be furnished and shall be 400 series stainless steel and/or Hilti type Tap-Fast w/Quickcoat™ and Flo Seal washer or equal.

C. All masonry fasteners shall be furnished and shall be stud Type Hilti Kwik Bolt II™ and/or Hilti Type Hit Anchors or equal.

D. All necessary drill bits shall be furnished.

PART 3. EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. Provide enclosure for all outdoor mounted backflow prevention devices.

B. Install enclosure level and/or plumb, where indicated on the Drawings.

C. Enclosure shall be mounted on a concrete pad with 50 mm (2”) minimum clearance on each side and be minimum 150 mm (6 in) thick above finished grade level.

1. Base Design Dimensions: 660 mm W x 1345 mm L x 150 mm thick (26"W x 53"L x 6" thick).

D. Enclosure shall be assembled and mounted to concrete pad according to Manufacturer’s written instructions.

E. Enclosure shall be assembled and mounted to concrete pad in such a way that it will remain locked and secured to pad even if outside screws are removed.

END OF SECTION

PART 1. GENERAL

1.1 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Basic Mechanical Materials, Methods and Requirements – Section 15050.

1.2 SUBMITTALS

A. Shop Drawings: Submit Product Data Sheets, in Shop Drawings form, for all products specified in this Section.

PART 2. PRODUCTS

2.1 GENERAL

A. All fire extinguishers are to be pressurized (stored pressure) rechargeable type, in accordance with NFPA 10, and ULC listed and labelled for the class of fires for which they are specified.

B. Each extinguisher is to be complete with:

1. A Manufacturer's identification label indicating the extinguisher model number, rating, and operating instructions.
2. An anodized aluminum or chrome plated forged brass valve with positive squeeze grip on-off operation and a pull-pin safety lock.
3. Discharge hose with nozzle or horn and hose securing clip.
4. For wall mounted extinguishers, a wall mounting bracket.

2.2 10-B.C. RATED CARBON DIOXIDE EXTINGUISHERS

A. Carbon dioxide extinguishers are to be 170 mm (6 ¾") diameter, 6.8 kg (15 lb.), each complete with an aluminum cylinder with a safety red baked enamel finish.

B. Acceptable Products are:

1. National Fire Equipment Ltd. Model CO2-150WW.

2. Wilson & Cousins Inc. Model CO2-150-WW.

3. Pyrene Corp. Model PSH15-7.

4. Amerex Model 331X.

5. Ansul Sentry Model CD10A.

2.3 10-A, 120-B.C. RATED DRY CHEMICAL EXTINGUISHERS

A. Multi-purpose dry chemical (ammonium phosphate) extinguishers are to be 181 mm (7-1/8") diameter, 9.08 Kg (20 lb.) each complete with a steel cylinder with a safety red baked enamel finish and a waterproof stainless steel pressure gauge.

B. Acceptable Products are:

1. National Fire Equipment Ltd. Model ABC-200WWD.

2. Strike First Corp Model WBDL-ABC20.

3. Oyro Chem Model PC 20 ABC+1.

4. Wilson & Cousins Inc. Model ABC-200W.

5. Pyrene Corp. Model 70609.

6. Ansul Sentry Model AA20.

2.4 IDENTIFICATION OF EXTINGUISHERS

A. Identify extinguishers in accordance with recommendations of latest edition of NFPA 10.

B. Include bilingual tag or label attached to extinguishers, indicating month and year of installation, with space for service dates.

PART 3. EXECUTION

3.1 INSTALLATION OF FIRE EXTINGUISHERS

A. Provide fire extinguishers of the type(s) indicated in the locations shown.

B. Unless otherwise shown or specified, wall mounted extinguishers using wall brackets supplied with the extinguishers.

C. Do not install extinguishers until after wall finishing work is complete.

D. Contractor will be responsible for fire extinguishers until after issue and receipt of a Certificate of Substantial Performance of the Work.

E. If extinguishers are indicated adjacent door, locate the extinguishers at the strike side of the door.

F. Fire extinguishers having a gross weight not exceeding 18.14 kg (40 lb) shall be installed so that the top of the fire extinguisher is not more than 1.53 m (5 f t) above the floor.

G. Fire extinguishers having a gross weight greater than 18.14 kg (40 lb) shall be installed so that the top of the fire extinguisher is not more than 1.07 m (3-1/2 ft) above the floor.

H. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 102 mm. (4 in).

3.2 CLOSEOUT ACTIVITIES

A. Provide in accordance with Section 01800.

END OF SECTION

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide air conditioning equipment as indicated and in compliance with Contract Documents.

1.2 SUBMITTALS

A. Submit the following Shop Drawings in accordance with Section 01330.

B. Shop Drawings: Submit Shop Drawings for all products specified in this Section.

C. Include certified power and control wiring schematics with each Shop Drawing.

D. Indicate the following in each Submittal: complete specifications; refrigerant charge per system including CSA B52 analysis; wiring diagrams; weight; performance details at specified conditions.

E. Test Data: Submit pipe leakage and flow test sheets, and other test data in accordance with requirements of Section 15050.

F. Start-up and Commissioning Data: Submit start-up and commissioning data in accordance with requirements of Section 15960.

1.3 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01400.

B. Manufacturer's Quality System:

1. Registered to ISO 9001:2000 Quality Standard, including in-house engineering for product design activities.

2. The control must be UL/ULC tested and certified.

C. Provide services of factory-trained Service Technician, specifically trained on type of equipment specified:

1. Service Technician must be present on site for all items listed below. Person-day requirements listed are exclusive of travel time, and do not relieve Contractor of the obligation to place equipment in operation as specified.

2. Installation: Inspect grouting, location of anchor bolts; setting, leveling, alignment, field erection; coordination of piping, electrical and miscellaneous utility connection:

   a. 2 person-days.

3. Functional Testing: Calibrate, check alignment and perform a functional test. Tests to include all items specified:

   a. 2 person-days.

4. Field Performance Testing: Field performance test equipment specified:

   a. 2 person-days.

5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts and preparation to lead and teach classroom sessions.

   a. 2 person-days.

6. Credit to the Owner, all unused service person-days specified above, at the Manufacturer's published field service rate.

D. Any additional time required of the factory trained Service Technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment or material shall be provided at no additional cost to the Owner.

1.4 DELIVERY STORAGE AND HANDLING:

A. Comply with the requirements specified in Section 01800.

PART 2 PRODUCTS

2.1 GENERAL

A. This Section includes the design, performance, refrigerant details, controls and installation requirements for Air-Conditioning systems.

B. All units shall be listed and rated by ANSI/AHRI Standard 1230 and meet all minimum IEER performance requirements as scheduled.

C. The units shall be CSA approved, ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the CETL label.

D. All wiring shall be in accordance with the National Electric Code (NEC) or Canadian Electric Code (CEC).

E. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

F. The units and the design shall be in compliance with CSA B52 Mechanical Refrigerant Code including the latest supplements.

2.2 SYSTEM DESCRIPTION

A. The variable capacity air conditioning system shall be a Bard Climate Control Solutions system as specified. The system shall consist of a packaged, outdoor wall-mounted unit., including the following components:

1. Copper Tube/Aluminum Fin Coils: Phenolic-coated grooved copper tubing and enhanced aluminum fins.

2. Blowers: dual blower configuration on slide tracks for service.

3. Cabinet: Galvanized 20 Gauge zinc coated steel cabinet provided with foil faced insulation. The cabinet to withstand 1000 hours of salt spray tests per ASTM B117-03.

4. Full Length Mounting Brackets: Built into cabinet for unit on-wall installation.

5. The unit shall be a direct expansion (DX), air-cooled, single-zone heat pump system with scroll compressors using R-410A refrigerant.

6. The unit shall be able to provide temperature set points via a local remote controller, and BMS interface (Fault and Operation Status Indication).

B. Unit built-in controller to be capable to control all the unit components, including, but not limited to:

1. Indoor Blower Control: The fan to be enabled if the system is set for continuous blower, economizer enabled, cooling stage 1, cooling stage 2, heating stage, freeze stat on, or a run test is started.

2. Temperature Control: Zone temperature control, cooling control, enthalpy economizer control, heating control. All controls to be field-adjustable.

3. Compressors control.

C. Unit built-in controller to be capable to provide the following alarms:

1. High Mixed Air Alarm: If the mixed air temperature sensor is above cooling temperature setpoint for longer than 10 seconds, the wall unit to generate a high mixed air alarm.

2. Low Mixed Air Alarm: If the mixed air temperature sensor is below 10°C for longer than 10 seconds, the wall unit to generate a low mixed air alarm.

3. Refrigerant Low Pressure: When the low pressure switch indicates a low pressure condition and there is an active call for cooling, the controller to generate an alarm after a delay. The delay used by the low pressure alarm is determined by the outdoor air temperature. If the outdoor air temperature is below 12.8°C, the delay is 180 seconds. If the outdoor temperature is above 12.8°C, the delay is 120 seconds. Additionally, if the outdoor temperature sensor is not used, the delay is set to 180 seconds. The controller to run the refrigeration system three (3) times before the alarm will lock the compressor out.

4. Economizer Damper: When the controller commands the economizer damper actuator to a position other than 0% and the damper switch indicates the damper is not open after a delay of 20 seconds, the controller to generate a damper failed to open alarm. When the controller commands the economizer damper actuator to the 0% position and the damper switch indicates the damper is not closed after a delay of 300 seconds, the controller to generate a damper failed to close alarm.

5. Freeze Stat Alarm: When the coil temperature is below -1.1°C for longer than 120 seconds, the controller to generate a freeze stat alarm. This to change the blower to high speed and turn off the compressor for 300 seconds or reset once the temperature has reached 14°C above the freeze stat temperature set point.

6. Fan Status Alarm: If the fan is commanded on and the fan status switch has not indicated the fan is running within 45 seconds, the system to generate an alarm.

2.3 ELECTRICAL REQUIREMENTS:

A. The power supply to the condensing units shall be as scheduled.

B. Independent electrical power for the unit shall be 208 volts, 3 phase, 60 hertz. The unit shall be capable of operating within the limits of 197 volts to 253 volts.

C. Individual disconnect switches for each unit are required and are to be supplied by Division 15 and installed by Division 16.

2.4 CONTROL REQUIREMENTS

A. The units shall be supplied with Individual Controllers.

B. Remote controllers shall be hard wired by installing Contractor.

C. Controllers shall be able to function as follows:

1. The controller shall have dual or single cool and heat setpoints.

2. The controller shall the ability to digitally prohibit individual buttons and functions.

3. The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions.

4. An LCD digital display will allow the temperature to be set in 1 degree C units.

5. The controller shall be equipped with a thermostat sensor.

6. The controller shall have the ability to automatically changeover the mode of operation with dual or single setpoints.

7. Controller shall have built-in 7-day, weekday plus Saturday and Sunday (5+1+1), weekday plus weekend (5+2) and everyday (1) scheduler.

8. Controller shall have a simple display mode, displaying only the operation mode, the setpoint(s), and the room temperature.

D. The system shall provide status and error output signals. Provide additional relay box to indicate general alarm to SCADA.

E. Provide a control module to allow full integration with a BACnet compatible BMS.

2.5 ACCEPTABLE MANUFACTURERS:

A. Acceptable Air Conditioning Equipment Manufacturers are as follows:

1. Bard Climate Control Solutions (MITS Airconditioning Inc.).

2. Specific Systems Ltd.
3. Shield Air Solutions Inc.
4. Or equal approved.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS:

A. Provide all required refrigerant, and, where equipment is not complete with a refrigerant charging valve, site install a charging valve in an accessible location.

3.2 AIR CONDITIONING UNITS:

A. Provide air conditioning systems.

B. Provide intermediate supports as recommended by the Equipment Manufacturer.

C. Contact Manufacturer or its official representative prior to installation to review and confirm equipment installation.

D. Provide all required control wiring and power wiring required for a complete installation.

E. Hand a remote controller for each system to the electrical trade at the site for installation as part of the work of Division 16. Supply certified control and power wiring schematics and hand to the electrical trade with the controllers.

F. Manufacturer’s agent shall commission the system.

3.3 START-UP AND WARRANTY

A. The system must be installed by Contractor, who is trained and certified by the Acceptable Manufacturer or his official representative. The bidders shall be required to submit training certification proof with bid documents.

B. The Manufacturer shall provide a factory trained Service Technician to start-up each unit. Manufacturer shall provide instruction to the owners' personnel on proper unit operation and maintenance.

C. The warranty period on all parts and compressors shall continue for a period of ten (10) years from the date of substantial performance of the project. Manufacturer's warranty shall include all parts and labour to install parts.

3.4 CLOSEOUT ACTIVITIES:

A. Provide in accordance with Section 01800.

END OF SECTION

PART 1. GENERAL

1.1 CONTRACT REQUIREMENTS

A. The successful Commissioning Agent will be responsible for the performance of the HVAC commissioning work specified in this Section. The Commissioning Agent will not, in any way, be responsible to the Contractor performing the building construction work. The Commissioning Agent services will be paid for under the Contract.

B. Definitions: The following are the definitions of words found in this Section:

1. Consultant: AECOM.

2. Commissioning Agent: The person or firm to perform the work of this Section.

3. Testing and Balancing Agency: The person or firm in Contract with the Commissioning Agent to perform air and water quantity flow balancing and testing specified in this Section.

1.2 COMMISSIONING & TAB AGENT

A. The Commissioning Agent is to have a minimum of five (5) years experience in satisfactorily commissioning projects for this type and magnitude. Reference shall be supplied.

B. Acceptable Commissioning Agents:

1. WSP Global (former MMM Group Limited) (905-882-4211, ext. 6752).

2. JLL (former Hunter Facilities Management) (905-666-9175).

C. Acceptable Testing and Balancing Agents:

1. Design Test & Balancing Co. (905-886-6513).

2. John Price Enterprises (416-755-4676).

3. Airwaso (519-652-4040).

4. Technical Aire Balancing Inc. (416-492-9408).

5. Air Adjustments & Balancing Inc. (416-254-3004).

6. Flowset Balancing Ltd. (416-410-9793).

1.3 QUALITY ASSURANCE

A. Work specified in this Section shall be performed by an Independent Agency specialising in this type of work.

B. Balancing of both air and water systems and sound level readings shall be performed by the same agency.

C. Balancing Procedures shall be in accordance with the latest, current requirements of "National Environmental Balancing Bureau" (NEBB) or "Associated Air Balance Council" (AABC):

1. NEBB Procedural Standards for Whole Building Systems Commissioning of New Construction.

2. NEBB Procedural Standards for Testing Adjusting And Balancing of Environmental Systems.

3. NEBB Procedural Standards for Retro- Commissioning of Existing Buildings.

4. AABC National Standards for Total System Balance.

5. AABC Test and Balance Procedures.

1.4 SCOPE OF WORK

A. The Commissioning Agent is to supply all labour, services and instruments to complete the following work:

1. Construction Phase:

a. Visit site once every two weeks (minimum), after mechanical work commences to examine the installation and submit a site visit report to the Owner and Consultant.

b. Attend site meetings with the Consultant and Contractor, to be scheduled during a site visit, to review Start-Up and Commissioning Procedures and to confirm procedures to be followed on this Project.

c. Monitor the Contractor's schedule with relation to Start-Up and Commissioning Procedures.

d. Secure the services of a testing and balancing agency to perform air and water quantity flow balancing and testing as specified in this Section.

e. Compile all required data and prepare the Operating and Maintenance Manuals and Operator's Manual.

f. Review on site, during specified site visits, white print set Record Drawings kept and maintained by the Contractor and submit a report to indicate the state of the Record Drawings.

g. Review Piping System Leakage Test Procedures with the Contractor and arrange to obtain signed copies of test sheets.

h. Attend site meetings on an "as needed" basis.

2. Construction Completion Phase:

a. Visit the site on an "as needed" basis to inspect visibly the condition of equipment and systems to determine completion and suitability for start-up.

b. In cooperation with Equipment Manufacturer's representatives and the Contractor, start-up equipment and systems, prepare start-up reports, and ensure that the equipment and systems are ready for performance testing and balancing.

c. Arrange for the testing and balancing agency to test and balance the equipment and systems and submit reports.

d. Verify the accuracy of the testing and balancing agency's report, review and approve the report and submit copies to the Consultant.

e. Supervise performance testing of equipment and systems throughout complete operating ranges and described sequences of operation, ensure that each piece of equipment and each system operates as intended, prepare performance testing reports, and submit reports to the Consultant.

f. Involve the Owner's operating and maintenance personnel in all work of this phase, and thoroughly instruct the operating and maintenance personnel in all aspects of operating and maintenance of each piece of equipment and each system.

g. Compile copies of certificates, leakage test result sheets, Equipment Manufacturers verification sheets, operating and maintenance data sheets, testing and balancing reports, start-up and commissioning sheets, etc., and produce Operating and Maintenance Instruction Manuals, and the Operator's Manual.

h. Review the Contractor's complete white print set of Record Drawings and when the Drawings are complete, obtain CADD discs from the Consultant, revise the discs to incorporate "as-built" conditions indicated on the white print Record Drawing set, produce a set of Record Drawings from the revised CADD discs, and hand the Record Drawings and the revised discs to the Owner.

3. Post Completion Phase:

    a. Visit the site quarterly for the year after commissioning is complete to ensure that equipment and systems are operating as per design intention, prepare a report after each visit, and submit the report to the Owner and Consultant.

    b. Review seasonal Operation and Maintenance Procedures with the Owner's operating staff.

    c. Review operating and maintenance problems with the Owner's staff and advise on correctional procedures.

    d. Ensure that Operating and Maintenance Procedures outlined in the manuals are being followed.

    e. Review deficiencies reported by the Owner's staff and advise on proper procedures to have deficiencies corrected.

    f. Approximately one month prior to expiry of the Contract warranty period, visit the site with the Consultant and Contractor and assist the Consultant to produce a warranty inspection report.

B. System and equipment involved with the commissioning work of this Section are:

1. Potable water systems and equipment.

2. Air conditioning system and equipment.

3. Control systems.

1.5 RELATED WORK SPECIFIED IN OTHER SECTIONS

A. Refer to all other Sections of Division 15 of the Specification.

1.6 COMMISSIONING SCHEDULE

A. At the proper time, as decided by the Contractor, and Commissioning Agent, the Commissioning Agent is to attend a site meeting to review the Contractor's start-up and commissioning schedule.

B. The schedule, when agreed to by all parties, will be issued to all parties by the Contractor, and every effort is to be made by the Commissioning Agent to adhere to the schedule.

C. The Commissioning Agent is to ensure that the Owner's operating and maintenance staffs have a copy of the schedule, and the Commissioning Agent is to arrange for as many operating and maintenance staff members as possible to be present during each day of commissioning.

1.7 SUBMITTALS

A. The Commissioning Agent is to prepare all required submittals specified in this Section, including, but not limited to the following:

1. Bi-weekly site visit reports.
2. Reports regarding status of Record Drawings on site and the completed Record Drawings and updated CADD discs.
3. System and equipment start-up, performance testing and commissioning reports.
4. Air and heat transfer system testing and balancing reports.
5. Operating and Maintenance Manuals and the Operator's Manual.
6. All required certificates, leakage test reports, etc.
7. Quarterly post construction inspection reports.

PART 2. PRODUCTS

2.1 INSTRUMENT TEST PORTS

A. Duro-Dyne of Canada Ltd. #1P1 or #1P2 (to suit insulation thickness where applicable) or approved equivalent gasketed, leakproof instrument test ports for round or rectangular ducts as required, each complete with a neoprene expansion plug and a plug securing chain.

PART 3. EXECUTION

3.1 SITE VISITS

A. The Commissioning Agent is to schedule all site visits.

3.2 SCHEDULING START-UP AND COMMISSIONING WORK

A. The Contractor, as per Article #1.4 above, is responsible for scheduling start-up and commissioning work.

B. After Start-Up Procedures commence, the Commissioning Agent is responsible for ensuring that his own personnel, including the testing and balancing agency, maintain the Contractor's schedule.

3.3 EQUIPMENT AND SYSTEM START-UP PROCEDURES

A. In accordance with the start-up schedule, the Commissioning Agent is to supply all labour, instruments and services to witness and assist in the supervision of equipment and system Start-Up Procedures.

B. The Commissioning Agent is to document all Start-Up Procedures on start-up check sheets. The Commissioning Agent is to supply start-up and check sheets as required.

C. The Contractor will supply labour for Start-Up Procedures and labour and materials for any repairs required as a result of Start-Up Procedures. The Contractor will also arrange and pay for the services of Equipment Manufacturer's representatives to supervise Start-Up Procedures, and the Contractor will forward to the Commissioning Agent, a copy of each Manufacturer's start-up sheet.

D. The Commissioning Agent is to forward a copy of their start-up sheet to the Contractor.

3.4 TESTING AND BALANCING AGENCY

A. Testing and balancing of air and fluid flows and quantities is specified below in this Section.

B. The Testing and Balancing Agency is to be retained by and paid by the Commissioning Agent and is to be a specialist company having successfully completed testing, adjusting and balancing of mechanical systems for a minimum of five (5) projects of similar size and scope during the past two (2) years. The testing and balancing agency is to be retained as soon as possible after the Commissioning Agent has a Contract with the Contractor.

C. The testing and balancing agency shall be a member in good standing with either the American Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

3.5 AIR AND FLUID QUANTITY FLOW TESTING AND BALANCING

A. The testing and balancing agency is to:

1. As soon as possible after award of Contract, the testing and balancing agency is to carefully examine a set of Mechanical Drawings with respect to routing of services and location of balancing devices and is to report the results of the evaluation to the Commissioning Agent, with a copy of the report to be sent to the Consultant.

2. The set of Drawings examined by the agency is to be returned to the Consultant with the evaluation report, marked-up to indicate locations for duct system test plugs, and required revision work such as relocation of balancing devices and locations for additional devices.

3. After careful review of the Mechanical Work Drawings and Specifications, the testing and balancing agency is to visit the site at frequent, regular intervals with the Commissioning Agent, during construction of the mechanical systems, to observe routing of services, locations of testing and balancing devices, workmanship, and anything else that will affect testing, adjusting and balancing.

4. After each site visit, the agency is to report results of the site visit to the Commissioning Agent, with a copy of the report to be sent to the Consultant, indicating the date and time of the visit, and detailed recommendations for any corrective work required to ensure proper adjusting and balancing.

5. Testing, adjusting and balancing of the complete mechanical systems is to be performed over the entire operating range of each system in accordance with the most stringent requirements of the AABC National Standards for Total System Balance or the NEBB Procedural Standards For Testing, Adjusting, Balancing Of Environmental Systems in order to obtain optimum systems performance.

6. Testing, adjusting and balancing work is not to begin until:

    a. Building construction work is substantially complete.

    b. Mechanical systems are complete in all respects, and have been checked, started, adjusted, and then performance tested in the presence of and to the satisfaction of the Commissioning Agent.

7. All mechanical systems to be tested, adjusted and balanced will be maintained in full, normal operation during each day of testing, adjusting and balancing.

8. The testing and balancing agency is to balance all systems with due regard to objectionable noise which is to be a factor when adjusting fan speeds and performing terminal work such as adjusting grille and diffuser air quantities, and should objectionable noise occur at the design conditions, the agency is to immediately report the problem to the Commissioning Agent and the Consultant and submit data, including sound readings, to permit an accurate assessment of the noise problem to be made.

9. The testing and balancing agency is to check all ventilation system mixing plenums for stratification, and where the variation of mixed air temperature across coils is found to be in excess of plus or minus 5 percent of design requirements, the agency is to report to the Commissioning Agent and the Consultant and issue a detail sketch of plenum baffle(s) required to eliminate the stratification.

10. The agency is to perform testing, adjusting and balancing to within plus or minus 5 percent of design values, and make and record measurements which are within plus or minus 2 percent of actual values.

11. The testing and balancing agency is to provide and install new sheaves and belts required for final air balance.

12. The testing and balancing agency is to provide and install instrument test ports in all main ducts at connections to fans, plenums or casings, in all larger branch duct connections to mains, and wherever else required for proper air quantity balancing and testing.

13. Wherever possible, the agency is to lock all balancing devices in place at the proper setting, and permanently mark settings on all devices.

14. The agency is to prepare and submit to the Commissioning Agent and Consultant when work is complete, a bound, identified copy of a testing and balancing report, prepared using standard AABC, NEBB or equal forms to indicate all measurements required by the referenced balancing standard, including, but not limited to, the following:

    a. Ventilation system measurements for:

        i. Air velocity.

        ii. Static pressure.

        iii. Velocity pressure.

        iv. Temperatures (wet bulb and dry bulb).

        v. Cross sectional area.

        vi. Rpm.

vii. Electrical power voltage and current draw.

b. Ventilation systems that include filters are to be balanced simulating filters at a dirty state as follows:

i. Pre-filter only – 250 pa (1" wg).

ii. Pre-filter & final filter combination – 400 pa (1.6" wg).

c. Ventilation system location of system measurements at:

i. Main ducts.

ii. Main branch.

iii. Sub-branch ducts.

iv. Each supply, return and exhaust air inlet and outlet.

v. All other auxiliary equipment.

vi. All areas served by the system.

15. The testing and balancing agency is to include for each system to be tested, adjusted and balanced, a neatly drawn, identified (system designation, plant equipment location, and area served) schematic “As-Built” Diagram indicating all equipment and accessories.

16. The agency is to include report sheets indicating building comfort test readings for all rooms.

17. The agency is to prepare report sheets using the units of measurements (SI or Imperial) as used on the project construction documents.

18. When testing, adjusting, and balancing work is complete and the balancing report has been accepted, the Commissioning Agent is to submit to the Owner, in the name of the Owner, an AABC National Guaranty Certification or a NEBB Quality Assurance Program Conformance Bond, and, in addition, the Commissioning Agent is to submit to the Owner, in the name of the Owner, a written extended warranty covering one full heating season and one full cooling season, during which time any balancing problems which occur in the buildings, with the exception of minor revision work done during scheduled site visits, will, at no cost, be investigated by the Commissioning Agent and reported on to the Owner, and if it is determined that the problems are a result of improper testing, adjusting and balancing, they are to be immediately corrected without additional cost to the Owner.

19. After completion of testing, adjusting and balancing work and acceptance of the report, the testing and balancing agency and the Commissioning Agent are to make the following follow-up site visits:

    a. Once during the first month of building operation.

    b. Once during the third month of building operation.

    c. Once between the fourth and tenth months in a season opposite to the first and third month visit.

20. During each return visit and accompanied by the Owner's representative, the testing and balancing agency is to spot rebalance terminal units as required to suit building occupants and eliminate complaints.

21. The Commissioning Agent is to schedule each visit with the Owner and inform the Consultant.

22. After each follow-up site visit, the Commissioning Agent is to issue to the Owner and Consultant a report indicating any corrective work performed during the visit, all abnormal conditions and complaints encountered, and recommended corrective action.

3.6 PERFORMANCE TESTING

A. Performance testing is to commence as soon as possible after Start-Up Procedures have been satisfactorily completed and is to coincide with air and fluid flow balancing and testing and testing and set-up of the Control System/SCADA System.

B. The Contractor will supply on-site qualified representatives of Equipment Manufacturers to conduct Performance Testing Procedures under the Commissioning Agent's direction, and to document procedures for their own records.

C. The Commissioning Agent is to document on his own standard sheets, all Performance Testing Procedures and performance data for each system and individual pieces of equipment.

D. Specific performance testing requirements for equipment include but are not limited to the following:

1. Ventilation Systems: The Manufacturer's Technician, under the Commissioning Agent's direction, is to adjust the fan equipment to design conditions, then, again under the Commissioning Agent's direction:

    a. The Technician is to revisit the site after one (1) month of operation and monitor the operation of the systems for a minimum period of four (4) hours running time, then issue a report to the Commissioning Agent, the Contractor, and the Consultant.

b. The Technician is to coordinate with the controls system trade to provide the necessary interface to the Control System/SCADA System and the Technician is to witness the Control System/SCADA System testing procedure for the ventilation units and sign the testing forms.

3.7 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

A. The Contractor will submit to the Commissioning Agent, six (6) copies of:

1. Permits, inspection certificates, and the like.

2. Shop Drawings for all mechanical equipment.

3. Pipe leakage test sheets, Manufacturer's start-up check sheets, and similar data.

4. All required operating and maintenance instruction data.

5. Valve tag charts.

6. All other data specified in applicable Sections of Division 15 of the Specification.

B. The Commissioning Agent is to prepare six (6) copies of the Operating and Maintenance Instruction Manual for the Owner's use. The manuals are to be in the Owner's hands a minimum of three weeks prior to Owner's staff training commencing, and each copy of the manual is to be contained in a good quality, vinyl covered, three ring (D-ring) binder.

C. Each manual is to be organized into the following categories:

1. A – Project Directory.

2. B – Plumbing and Drainage.

3. C – Heating.

4. D – Ventilation.

5. E – Fire Protection.

D. The project directory is to contain the names, addresses, fax numbers and telephone numbers of the Contractor, Subcontractors, Manufacturers and Manufacturer's representatives.

E. Sections B to E are to be divided into the following subsections:

1. Shop Drawings.

2. Operation Procedures.

3. Maintenance Procedures.

4. Spare Parts List.

5. Trouble Shooting Guide.

6. Valve Chart (where applicable).

7. Filter Size Chart (where applicable).

8. Equipment Lists.

9. Testing and Verification Forms.

10. Certification Forms.

F. The Operating Procedures are to be the Manufacturer's recommended Operating Procedures for the equipment.

G. The Maintenance Procedures are to include Scope of Work, frequency of activity, parts required, and necessary documentation.

H. The spare parts list is to be the Manufacturer's recommended list for maintenance purposes.

I. The trouble shooting guide is to be the Manufacturer's recommendations for the equipment.

J. The equipment list is to include make, model, serial number, electrical characteristics, RPM, pump impeller sizes, fan belt and sheave sizes, as applicable.

3.8 SYSTEMS OPERATION MANUAL

A. The Commissioning Agent is to prepare six (6) copies of the Systems Operation Manual, each contained in a three-ring binder as for maintenance manuals and submitted to the Owner prior to commencement of Site Training Procedures.

B. The Systems Operating Manual will be used by the Owner's operating staff to assist them in the daily operation of the systems within the facility.

C. Each manual is to be subdivided into the following systems as applicable.

1. Fans.

2. Control System/SCADA.

D. Each Section describing a system is to contain, as a minimum:

1. A basic description of the system.
2. Its location and areas it serves.
3. A basic description of operations.
4. Electrical services and locations.
5. Control System/SCADA control points alarm limits and setpoints.
6. Time of day schedules.
7. A schematic of the system.

3.9 OPERATOR TRAINING

A. Under the Commissioning Agent's direction and supervision, the Contractor and Equipment Manufacturer's representatives are to provide operator training for each mechanical system and piece of equipment to the Owner's staff.

B. The training is to be conducted in a room at the facility and at the equipment or system.

C. Training is to begin when the Operating and Maintenance Manuals have been delivered to the Consultant. Manuals shall be delivered a minimum of seven full working days prior to the commencement of training.

D. Each training session is to be structured to cover:

1. Operating and Maintenance Manual.
2. Operating Procedures.
3. Maintenance Procedures.
4. Trouble-Shooting Procedures.
5. The Manufacturers or Service Representatives name, address and phone number.

E. The Commissioning Agent is responsible for preparing a detailed training plan. This plan is to include the outline of all training sessions and is to identify the training presenters.

F. Training sessions are to be scheduled with the Owner's operating staff and are to continue until the Owner's staff is completely familiar with all Operating and Maintenance Procedures. Note that sessions will have to be repeated to ensure that staff members performing their normal duties will also be trained.

G. The Commissioning Agent is to record all training sessions and hand identified DVD's to the Consultant. Provide seven (7) copies on DVD which are playable on computer/laptop DVD drives.

3.10 FINAL TESTING

A. When all the start-up and performance testing has been completed and the associated forms signed and submitted, the Commissioning Agent is to begin the systems testing.

B. The Contractor and Manufacturer's representatives will be available during the testing period. Should deficiencies be found, the Commissioning Agent is to report to the Consultant. When the deficiencies have been corrected, the Commissioning Agent is to retest the system.

C. Tests will be for the purpose of verifying that the heating and cooling plants perform as required, regardless of outside conditions, and that all systems perform to design requirements.

D. The final testing of the boiler plant or chiller plant may be delayed. Testing is to occur in the fall or spring after the Contractor and Manufacturers have completed their testing.

3.11 RECORD DRAWINGS

A. When mechanical work on-site is complete, the Commissioning Agent is to obtain the Contractor's "As-Built" set of white prints which he has periodically checked during construction. The Commissioning Agent is to ensure that the white prints contain all "As-Built" information, including revisions made by Site Instructions, Change Orders and Addenda.

B. The Commissioning Agent is to obtain a set of CADD discs of the Contract Drawings from the Consultant and revise the discs in accordance with the as-built white prints to produce a true set of Record Drawings.

C. The Commissioning Agent is to identify each drawing as a "RECORD DRAWING" and is to hand two (2) sets of prints of Record Drawings and the CADD discs to the Owner.

END OF SECTION

DIVISION 16

ELECTRICAL

INDEX

PART 1. GENERAL

1.1 SUMMARY

A. Contract Drawings indicate the general location and route to be followed by major raceways and electrical equipment arrangements. The Contract Drawings do not show all structural, architectural and mechanical details. In some cases, conduit or wiring is shown only diagrammatically on the Contract Drawings and may not detail exact or complete wiring or raceway requirements.

B. To provide sufficient detail and the maximum degree of clarity on the Contract Drawings, symbols used for various electrical devices, particularly wall mounted devices, take up more space on Contract Drawings than devices physically do. Locate devices with primary regard for convenience of operation and space utilization, rather than stringing devices out so as to comply with scaled locations of electrical symbols.

C. The Contractor shall provide all required incidental devices to ensure a complete and fully functional working system.

D. The Contractor shall provide a temporary generator when needed to keep the Don Lita Lift Station running all times.

E. Refer to Specification Section 02050 and Drawings for demolition scope.

1.2 REFERENCES

A. CSA C22.2 No. 0 General Requirements – Canadian Electrical Code – Part 2.

B. CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V.

C. Electrical and Electronic Manufacturers Association of Canada (EEMAC).

D. National Electrical Manufacturers Association (NEMA).

E. Institute of the Electrical and Electronic Engineers (IEEE).

F. Insulated Cable Engineers Association (ICEA).

G. Canadian Standards Association (CSA).

H. Canadian Gas Association (CGA).

I. Underwriters Laboratories Canada (ULC).

J. American National Standards Institute (ANSI).

K. National Fire Protection Agency (NFPA).

L. Ontario Electrical Safety Code (OESC).

M. Comply with latest editions of the CSA Certification Standards and Bulletins.

1.3 DEFINITIONS

A. The following are definitions used in Division 16. Refer also to Division 1.

1. Inspection Authority means agent of any authority having jurisdiction over Construction and Safety Standards associated with any part of electrical site work.

2. GSU is the electrical power company or commission responsible for delivering electrical power to project site.

3. Electrical Code or Code means the Ontario Electrical Safety Code.

4. CEC means Canadian Electrical Code.

5. "Provide" is understood to mean "Supply and Install".

1.4 ELECTRICAL WORK DESCRIPTION

A. Items below where not noted for removal are new, unless noted otherwise:

1. Existing overhead service including conductors, poles, supports, grounding from primary connection point to Don Lita Lift Station by GSU. Coordinate removal of existing service with GSU. Existing pole mounted transformer to be disconnected and removed by GSU.

2. Removal of indoor and outdoor equipment associated with the backup generator and enclosure along with the peripheral components of the generator and all other electrical equipment, listed below, enclosed within:

a. Existing Main Fused Disconnect Switch.

b. Existing Automatic Transfer Switch.

c. Existing Pump Controller.

d. Existing Transformers.

e. Existing Lighting Panels.

3. Existing power distribution removal including conduit, wiring, supports to all existing loads including process, mechanical.

4. Utility Meter Disconnect Switch.

5. Utility Meter Socket/Enclosure as per GSU requirement.

6. 600V Automatic Transfer Switch.

7. Outdoor 150KW Generator with skintight enclosure.

8. 600V Motor Control Centre, distribution transformer and lighting panel.

9. Primary overhead service from GSU connection point at existing primary pole to pad mounted transformer including primary duct banks and cables, transformer, transformer vault, load break switch, ground gradient mat, conductors, utility rated poles, grounding, guys and supports by GSU. Coordinate service run with GSU. Transformer including grounding, collar, pad to be provided by GSU.

10. Transformer secondary duct banks and cables from pad mounted transformer to 600V MCC. Coordinate duct connection and cable connection at transformer with GSU.

11. Variable Frequency Drives and associated line, load filters.

12. Conduit and wire system.

13. Trenching and duct banks for buried conduit or cables within Don Lita Lift Station.

14. Grounding and bonding.

15. System studies in Section 16015.

16. Testing and commissioning.

17. Training.

18. Unless, indicated otherwise in the Contract Documents, all control panels shown on the Contract Drawings. All control panels shall be constructed in accordance with P&ID Drawings and in accordance with Division 13.

19. All control and 120 V power wiring required by Division 13010 (see P&ID Drawings and Device Control Wiring List).

20. Installation of control panels and electrical devices supplied by other Divisions.

21. Refer to Contract Drawings for details.

1.5 ACTION SUBMITTALS: PERMITS, INSPECTIONS, TEST REPORTS, CERTIFICATES AND FEES

A. Submit PDF of submittals in accordance with Section 01330 – Submittals.

B. Submit to the Consultant all necessary interim and final certificates of inspection and approval required by Inspection Authorities having jurisdiction over the work, as evidence that the work installed complies with laws and regulations of the governing authorities.

C. Submit all Shop Drawings and purpose made Drawings that are required by the Electrical Safety Authority.

D. Notify Inspection Authorities in sufficient time to inspect work.

E. Submit Inspection Authorities approval certificates.

F. Submit installation and energization certificates from Manufacturers of transformers, motor control centres, bus duct, variable frequency drive systems, power panel board, luminaires, emergency power systems and control systems.

G. Submit electrical equipment or system warranty certificates.

H. Report motor full load amps, type and size of overload heaters installed, breaker trip settings, fuse ratings and sizes of fuses in control circuits.

I. Report circuit insulation resistance.

J. Report on coordination of protective devices, including recommended and final field setting data and certified field test data.

K. Other requirements specified in the Contract Documents.

L. Pay associated fees and costs.

M. Information Submittals:

1. Submit PDF of submittals in accordance with Section 01330 – Submittals.

2. Factory test certification and reports for all major electrical equipment.

3. Site test certification and reports as specified in other Sections of Division 16 – Electrical.

1.6 COORDINATION

A. Coordination with Power Supply Authority:

1. Co-ordinate and meet all requirements of Greater Sudbury Hydro Inc.

2. Submit to Greater Sudbury Hydro Inc. necessary number of Drawings and Specifications for examination and approval prior to commencement of work.

3. Co- ordinate and schedule work with Greater Sudbury Hydro Inc.

4. Ensure the availability of electrical power service at all times.

5. Coordinate with Greater Sudbury Hydro Inc. for power supply transfer.

6. Greater Sudbury Hydro Inc to supply and install collar, pad, grounding and transformer. Coordinate linkages between collar and cabling with Hydro.

7. Pay all additional disbursements and associated connection fees/charges for Power Supply Authority Services.

B. Coordination with the City of Great Sudbury:

1. Co-ordinate and schedule all work with the City of Great Sudbury.

2. Co-ordinate with the City of Great Sudbury for the upgrade of the entire electrical system of the lift station.

3. Investigate existing underground condition and underground utility lines for the crossing of the underground electrical duct bank and direct buried conduits.

C. Coordination with Other Trades:

1. Coordinate with other Sub-trades and vendors work with electrical requirements and ensure that there is no interference with, or delay caused by such work to the electrical or other Trades work.

2. Notify other Sub-trades of all openings, inserts, anchors, sleeves, hangers, foundations, etc., necessary for electrical work, and be responsible that these are provided and correctly installed at the proper time.

3. Fully co-operate with all Trades in the provision and maintenance of electrical power in all areas throughout the period of construction.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with Manufacturer's written instructions.

B. Delivery and Acceptance Requirements: Deliver materials to site in original factory packaging, labelled with Manufacturer's name and address.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. For motor rewinding, employ fully trained, qualified and experienced in all aspects of such work.

2. For work involving specialties, for example, installation of high voltage switchgear and cables, sound and intercommunication systems, lightning protection systems, equipment cathodic protection, instrumentation and fibre optics systems, employ only workers fully trained, qualified and experienced in all aspects of such work.

B. Training Instructions, Operating and Maintenance Manuals:

1. Submit Training Instructions in accordance with Section 01800.

2. Submit Operating and Maintenance Manuals in accordance with Section 01800.

PART 2. PRODUCTS

2.1 DESIGN REQUIREMENTS

A. Operating Voltages: To CAN3-C235.

B. Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

C. Language Operating Requirements: Provide identification (labels /nameplates) for control items in English.

2.2 ACCEPTED MATERIALS

A. Materials: Approved by CSA or an independent agency accepted by the Inspection Authorities for use as installed. Where equipment or material is not approved or certified as indicated, obtain and pay for special acceptance from the Inspection Authorities or independent agency accepted by the Inspection Authorities.

B. Standards: Unless otherwise indicated in the Contract Documents, manufacture to meet the Standards of North American Standards Agencies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

A. Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.4 EQUIPMENT IDENTIFICATION

A. Identify electrical equipment with nameplate as follows:

1. Sizes as follows:

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

B. Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

C. Wording on nameplates to be approved by prior to manufacture.

D. Allow for minimum of 25 letters per nameplate.

E. Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

F. Disconnects, starters and contactors: indicate equipment being controlled and voltage.

G. Terminal cabinets and pull boxes: indicate system and voltage.

H. Transformers: Indicate capacity, primary and secondary voltages.

I. Refer to Division 13 – System Tagging.

2.5 WIRING IDENTIFICATION

A. identify wiring with permanent indelible identifying markings, on both ends of phase conductors of feeders and branch circuit wiring.

B. Maintain phase sequence and colour coding throughout.

C. Colour Coding: To CSA-C22.1.

D. Use colour coded wires in communication cables, matched throughout system.

2.6 CONDUIT AND CABLE IDENTIFICATION

A. Colour code conduits, boxes and metallic sheathed cables.

B. Code with plastic tape or paint at points where conduit or cable enters wall, ceiling or floor, and at 15 m intervals.

C. Colours: 25 mm wide prime colour and 20 m wide auxiliary colour.

Type	Prime	Auxiliary
Up to 250 V	Yellow	
Up to 600 V	Yellow	Green
Up to 5 kV	Yellow	Blue
Up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Security Systems	Red	Yellow

2.7 EQUIPMENT FINISH

A. Unless otherwise indicated in the Contract Documents, prepare, shop prime and factory finish electrical equipment in accordance with the requirements of Section 09911, colour ANSI/ASA 61 grey.

B. Where Site finishing is required, prepare and prime surfaces as specified in Section 09911 and 09912.

2.8 AMBIENT ENVIRONMENT

A. Unless otherwise indicated in the Contract Documents, supply equipment enclosures, boxes, electrical materials and products suitable for ambient environment of the following areas:

Area	Gen. Classification	Equipment Enclosure Type	Enclosure Material
Hazardous, Wet Well	Class 1 – Division 1 and 2	EEMAC 8	Stainless Steel
Outdoor	Wet	NEMA 4X	Stainless Steel

PART 3. EXECUTION

3.1 PREPARATION AND PROTECTION

A. Schedule expediting of materials and execution of work in conjunction with associated work of Other Contractors.

B. Post engraved warning signs to meet the requirements of the Inspection Authorities and the Consultant.

C. Protect those working on, or in the vicinity of, exposed electrically energized equipment from physical danger. Shield and mark live parts "LIVE - ___ VOLTS". Indicate the appropriate voltage.

D. Arrange for installation of temporary doors, barriers and similar items for access to rooms and areas containing electrical equipment. Keep these doors locked at all times, except when under direct supervision.

E. Permanently identify equipment energized from multiple power sources, noting voltages, power source locations, supply disconnect designations and grounding electrode location.

3.2 LOAD BALANCE

A. Contract Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on distribution panel boards and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.3 NAMEPLATES AND LABELS

A. Ensure Manufacturer’s nameplates, CSA labels and identification nameplates as per City of Greater Sudbury requirements are visible and legible after equipment is installed.

3.4 TESTS

A. Test and check electrical and instrumentation systems for correct operation and compliance with statutory and regulatory authority requirements.

B. Perform tests in presence of the Consultant. Log, tabulate, sign and include test results in Maintenance Data and Operating Instructions.

C. Test the following systems:

1. 600 V and 208V distribution systems, including cabling for correct phasing, voltage, grounding and load balancing.

2. Circuits originating from branch distribution panels.

3. Lighting and control.

4. Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

5. Communications, control and instrumentation and emergency power systems.

D. Refer to the appropriate Specification Sections for specific system or equipment tests.

E. Supply calibrated instruments, meters, consumable parts (such as fuses) and equipment. Arrange for qualified personnel to conduct tests.

F. In cooperation with other Subcontractors, take clamp-on ammeter readings with motors operating at full load. Log, tabulate and include readings in Maintenance Data and Operating Instructions.

G. Check electrical system voltages after facility has been in operation for 60 days. Adjust transformer tap settings as required. Tabulate, make adjustments and record data in Maintenance and Operating Instruction Manuals.

3.5 CO-ORDINATION OF PROTECTIVE DEVICES

A. Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

3.6 TOUCH-UP PAINTING

A. Field touch-up shop painted electrical equipment, including equipment supplied by the City.

B. Obtain necessary touch-up paint of original type and quality from the equipment Manufacturer.

C. Clean surfaces to be painted. Feather out edges of scratch marks. Make patches inconspicuous.

D. Apply one or more coats until the damaged surface has been restored to its original finish condition.

E. Do not paint nameplates, tags, warning plates and operating instructions. Observe field painting of electrical equipment or raceways.

3.7 SUPPORTS AND HANGERS

A. Provide supports, hangers, plates and hardware required for electrical and instrumentation equipment.

B. Hot dip galvanized prefabricated steel supports, such as channels, struts, brackets, hangers, slotted angles and similar items. Bolt or clamp these supports. Do not field weld. Repaint cut sections with zinc rich galvanizing primer.

C. Bond metallic supports to grounding electrode. Do not use metallic supports as ground conductors for electrical equipment.

D. Provide non-corroding, 6 mm minimum, nylon or lead spacers for fastening enclosures to masonry walls.

E. Provide expansion anchors, Type HKD by Hilti (Canada) Ltd. or Redhead Multi-Set II by Phillips and machine screws or threaded rods and nuts for supporting hangers or straps.

F. Provide UCAN SCRU-IT or TAPCON Fasteners, or KWIK-CON II Anchors by Hilti (Canada) Ltd. for attaching conduit straps, conduit fittings, boxes, control stations and similar items to concrete.

G. Do not use power-actuated tools without the prior, written consent of the Consultant.

H. Provide fire retardant, treated plywood backboards.

3.8 CUTTING AND PATCHING

A. Bear costs for any cutting and patching resulting from the Contractor's failure to coordinate timely installation of electrical inserts, sleeves and similar items into structures.

3.9 CLEANING

A. Vacuum all construction debris and materials from the inside and outside of enclosures, before final electrical tests.

B. Clean luminaire reflectors, lenses and other surfaces exposed to construction dust and dirt.

3.10 PROVISION FOR FUTURE EXPANSION

A. In each location where space for future equipment is indicated in the Contract Documents, leave such space clean. Install conduit, wiring and other work in such a manner that necessary connections can be made in future without dismantling existing equipment, raceways or wiring. Consult with the Consultant whenever necessary.

END OF SECTION

PART 1. GENERAL

1.1 WORK DESCRIPTION

A. Electrical system analysis needs to be conducted for the following:

1. Don Lita Lift Station.

B. Site investigation for the information needed for the system analysis.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. NETA International Electrical Testing Association Standards for Power System Studies for:

   a. Section 6.1 for Short Circuit Studies.

   b. Section 6.2 for Coordination Studies.

   c. Section 6.3 for Arc Flash Studies.

2. CSA Z462 Latest Version and NFPA 70E – Standard for Electrical Safety in the Workplace.

3. Ontario Electrical Safety Code, 27th Edition/2018.

4. IEEE-1584 Latest Version, Guide for Performing Arc Flash Hazard Calculations.

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings, to include:

1. Short Circuit Study.

2. Protective Device Coordination Study.

3. Arc Flash Study.

1.4 QUALITY ASSURANCE

A. Short circuit, protective device coordination studies and arc flash studies shall be prepared by one of the following:

1. Eaton Electrical Services & Systems.
2. G.T. Wood.
3. Schneider Engineering Services.

B. Training Instructions, Operating and Maintenance Manual.

1. Submit Training Instructions in accordance with Section 01800.
2. Submit Operating and Maintenance Manuals in accordance with Section 01330 – Submittals.

1.5 QUALITY ASSURANCE

A. Equipment and component titles used in the studies shall be identical to the equipment and component titles shown on the Drawings.

B. Perform studies using windows based software such as ETAP or SKM.

C. Provide one Draft Report for Consultant review prior to ordering major equipment and a Final Report on addressing of any comments from the Consultant in the Draft Report.

D. Perform complete fault calculations for all switching scenarios.

E. Device coordination time-current curves from 12kV system point of connection to downstream MCC and large 600 Volt motors.

1.6 SHORT CIRCUIT STUDY

A. Provide:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagrams.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.

5. Impedance diagrams.

6. Zero sequence impedance diagrams.

7. Typical calculation.

8. Tabulations of calculated quantities.

9. Results, conclusions, and recommendations.

B. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at:

1. 600V Motor Control Center.

2. Branch circuit panelboard.

C. Provide a bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

D. Provide a bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Verify:

1. Equipment and protective devices are applied within their ratings.

2. Adequacy of bus bars to withstand short circuit stresses.

3. Adequacy of transformer windings to withstand short circuit stresses.

4. Cable and busway sizes for ability to withstand short circuit heating, besides normal load currents.

1.7 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.

B. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by Manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot Characteristics on Curve Sheets:

1. Electric utility's relays.
2. Electric utility's fuses including Manufacturer's minimum melt, total clearing, tolerance, and damage bands.
3. Medium voltage equipment relays.
4. Medium and low voltage fuses including Manufacturer's minimum melt, total clearing, tolerance, and damage bands.
5. Low voltage equipment circuit breaker trip devices, including Manufacturer's tolerance bands.
6. Pertinent transformer full-load currents at 100 and 600 percent.
7. Transformer magnetizing inrush currents.
8. Transformer damage curves.
9. ANSI transformers withstand parameters.
10. Significant symmetrical and asymmetrical fault currents.
11. Ground fault protective device settings.
12. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

F. Primary Protective Device Settings for Wye-Wye and Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within the transformer's characteristics curve, including a point equal to 58 percent of ANSI C57.12.00 withstand point.
2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

G. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.

1.8 ARC FLASH STUDY

A. Arc Flash study is to be performed as per NFPA 70E, IEEE Standard 1584, and CSA-Z462.

B. Provide lamicoid labels (to include Arc Flash Boundary, Incident Energy and Hazard/Risk Category for Protective Clothing) for the following:

1. All new equipment/devices in Don Lita Lift Station.

C. Arc flash boundary to be permanently outlined on floor surrounding equipment.

D. Arc flash hazard above Level 3 are not generally acceptable. Where these exist, provide recommendations for achieving reduction of arc flash hazard.

1.9 TABULATIONS

A. General Data:

1. Short circuit data.
2. Short circuit reactances of rotating machines.
3. Cable and conduit material data.
4. Bus data transformer data.
5. Circuit resistance and reactance values.

B. Short Circuit Data:

1. Fault impedances.
2. X to R ratios.
3. Asymmetry factors.
4. Motor contributions.
5. Short circuit kVA.
6. Symmetrical and asymmetrical fault currents.

C. Recommended Protective Device Settings:

1. Relays:
   a. Current tap.
   b. Time dial.
   c. Instantaneous pickup.
2. Circuit Breakers:
   a. Adjustable pickup.

b. Adjustable time-current characteristic.

c. Adjustable instantaneous pickup.

1.10 STUDY ANALYSIS

A. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit and coordination studies.
6. Comments or suggestions.

B. Suggest changes and additions to equipment rating and/or characteristics.

C. Notify the Consultant in writing of existing circuit protective devices improperly rated for new fault conditions.

PART 2. PRODUCTS (NOT USED)

PART 3. EXECUTION

3.1 GENERAL

A. Program all protective relays according to values established by the coordination study. Provide list of parameter settings to the Engineer for review.

B. Make minor modifications to equipment as required to accomplish conformance with the short circuit and protective device coordination studies.

C. Notify the Consultant in writing of any required major equipment modifications.

D. Post arc flash labels on the electrical equipment.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. CSA C22.2 No. 0 General Requirements – Canadian Electrical Code – Part 2.

B. CAN3-C235 Preferred Voltage Levels for AC Systems, 0-50,000 V.

C. Electrical and Electronic Manufacturers Association of Canada (EEMAC).

D. National Electrical Manufacturers Association (NEMA).

E. Institute of the Electrical and Electronic Engineers (IEEE).

F. Insulated Cable Engineers Association (ICEA).

G. Canadian Standards Association (CSA).

H. Canadian Gas Association (CGA).

I. Underwriters Laboratories Canada (ULC).

J. American National Standards Institute (ANSI).

K. National Fire Protection Agency (NFPA).

L. Ontario Electrical Safety Code (OESC).

M. Comply with the latest editions of CSA C22.1 Canadian Electrical Code – Part 1, Provincial Electrical Authority Safety Codes and Bulletins, and local codes and requirements which govern the installation. Where these regulations conflict, comply with the most stringent condition.

N. Comply with latest editions of the CSA Certification Standards and Bulletins.

O. Instrument Society of America (ISA): RP12.6, Wiring Practices for Hazardous (Classified) Locations Instrumentation – Part I: Intrinsic Safety.

P. Underwriters Laboratories Inc. (UL).

1.2 DEFINITIONS

A. The following are definitions used in Division 16 – Electrical. Refer also to Division 1 – General Requirements:

1. Inspection Authority means agent of any authority having jurisdiction over Construction and Safety Standards associated with any part of electrical site work.

2. Supply Authority is Greater Sudbury Hydro Inc., which is the electrical power company responsible for delivering electrical power to the site.

3. Electrical Code or Code means Ontario Electrical Safety Code.

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings:

1. Device boxes for use in hazardous areas.

2. Junction and pull boxes used at or below grade.

3. Large junction and pull boxes.

4. Terminal junction boxes.

5. Panelboards and circuit breaker data.

6. Wiring devices.

7. Control devices.

8. Control relays.

9. Timers.

10. Fuses.

11. Magnetic contactors.

12. For cabling in duct banks provide cable Manufacturer's instructions including lubricant used, maximum allowable pulling tension, maximum allowable pulling speed, and maximum allowable bending radii.

C. Information Submittals: Test Report: Sound test certification for dry type power transformers (0 to 600-volt, primary).

1.4 QUALITY ASSURANCE

A. CSA or ULC Compliance: Materials manufactured within scope of Underwriters Laboratories shall conform to ULC Standards and have an applied ULC listing mark.

B. Hazardous Areas: Materials and devices shall be specifically approved for hazardous areas of the class, division, and group shown and of a construction that will ensure safe performance when properly used and maintained.

C. Training Instructions, Operating and Maintenance Manuals:

1. Submit Training Instructions in accordance with Section 01800.

2. Submit Operating and Maintenance Manuals in accordance with Section 01330.

1.5 EXTRA MATERIAL

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2. PRODUCTS

2.1 METERING FACILITIES

A. Furnish material as required by electric utility for utility's installation of metering equipment, service conductors, and mounting of utility company equipment.

2.2 ACCEPTABLE MANUFACTURERS IN HAZARDOUS AREAS

A. In the Wet Well and Dry Well, provide all Electrical products from Hubbell/Killark, or Cooper/Crouse-Hinds.

2.3 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.

2. Cover: Gasketed, weatherproof, cast ferrous metal**,** with stainless steel screws.

3. Hubs: Threaded.

4. Lugs: Cast Mounting.

C. Cast Aluminum:

1. Material:

a. Box: Cast, copper-free aluminum.

b. Cover: Gasketed, weatherproof, cast copper-free aluminum with stainless steel screws.

2. Hubs: Threaded.

3. Lugs: Cast mounting.

D. PVC-Coated Cast Metal:

1. Type: One-piece.

2. Material: Malleable iron, cast ferrous metal or cast aluminum.

3. Coating:

a. All exterior surfaces; 40-mil PVC.

b. All interior surfaces, 2 mils urethane.

E. Non-metallic:

1. Box: PVC.

2. Cover: PVC, weatherproof, with stainless steel screws.

2.4 JUNCTION AND PULL BOXES

A. Outlet Boxes Used as Junction or Pull Box: As specified under Subsection 2.1, Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Subsection 2.2, Fittings.

C. Large Sheet Steel Box:

1. EEMAC 250, Type 1.

2. Box: Code-gauge, galvanized steel.

3. Cover: Full access, screw type.

4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

1. EEMAC 250, Type 4.

2. Box: Cast ferrous metal with drilled and tapped conduit entrances and exterior mounting lugs.

3. Cover: Hinged.

4. Gasket: Neoprene.

5. Hardware and Machine Screws: ASTM A167, Type 316 Stainless Steel.

E. Large Cast Metal Box, Hazardous Locations:

1. EEMAC Type 7, 8 or 9 as required for Class, Zone/Division, and Group involved.

2. Box: Cast ferrous metal, electro-galvanize finished or copper-free aluminum with drilled and tapped conduit entrances.

3. Cover: Hinged with screws.

4. Hardware and Machine Screws: ASTM A167, Type 316 Stainless Steel.

F. Large Cast Aluminum Box:

1. EEMAC Type 4.

2. Box: Cast copper-free aluminum, with drilled and tapped conduit entrances and exterior mounting lugs.

3. Cover: Nonhinged.

4. Gasket: Neoprene.

5. Hardware and Machine Screws: ASTM A167, Type 316 Stainless Steel.

G. Large Stainless Steel Box:

1. EEMAC Type 4X.

2. Box: 14-gauge, ASTM A240, stainless steel with white enamel painted interior mounting panel.

3. Cover: Hinged with clamps.

4. Hardware and Machine Screws: ASTM A167, Stainless Steel.

H. Large Steel Box:

1. EEMAC Type 3R.

2. Box: steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces.

3. Cover: Hinged with clamps.

4. Hardware and Machine Screws: ASTM A167, Type 316 Stainless Steel.

I. Large Non-Metallic Box:

1. EEMAC Type 4X.

2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.

3. Cover: Hinged with clamps.

4. Hardware and Machine Screws: ASTM A167, Type 316 Stainless Steel.

5. Conduit hubs and mounting lugs.

J. Concrete Box, Non-Traffic Areas:

1. Box: Reinforced, cast concrete with extension.

2. Cover: Steel diamond plate with locking bolts.

3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown on the Drawings.

4. Size: 254 mm by 432 mm (minimum).

K. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.

2. Cover: Steel checked plate. H/20 loading with screw down.

3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown on the Drawings.

2.5 WIRING DEVICES

A. Lighting Switches:

1. Single pole, Decora type, electronic timer.
2. Four preset time intervals of 2-4-8-12 hours, plus OFF position.
3. Single, three way or four-way operation as indicated.
4. Rating: 120 volt, 20A, 1000 watt, 1hp.
5. Color: White.

B. Receptacle, Single and Duplex:

1. Heavy duty, specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
2. High strength, thermoplastic base colour.
3. Color:
    a. Office Areas: White.
    b. Other Areas: Brown.
4. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
5. Rating: 125 volts, NEMA WD 1, Configuration 5-15R, 15 amps.
6. One-piece mounting strap with integral ground contact (rivetless construction).

C. Receptacle, Ground Fault Circuit Interrupter:

1. Duplex, tripping at 5 mA.
2. Color: Brown.
3. Rating: 125 volts, CSA, Configuration: 5-15R, 15 amps.
4. Size: For 50 mm by 100 mm outlet boxes.
5. Standard Model: CSA, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.
6. Feed-Through Model: CSA, with No. 12 AWG copper USE/RHH/RHW-XLPE insulated pigtails and provisions for testing.

7. Impact resistant nylon face.

D. Switch, General Purpose:

1. NEMA WD 1.
2. Totally enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contacts.
4. Capable of controlling induction and fluorescent lamp loads.
5. Rating: 20 amps, 120/277 volts.
6. Color:
    a. Office Areas: As indicated on Drawings.
    b. Other Areas: Brown.
7. Switch with Pilot Light: 125 volts, LED light with red jewel.
8. Automatic grounding clip and integral grounding terminal on mounting strap.

E. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. Enclosure/Mounting and Rating:
    a. General Purpose:
        1. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. UL 508 listed.
        2. General Purpose Rating: 30 amperes, 600V ac.
        3. Minimum Motor Ratings:
            i. 1.5 kW for 120V ac, single-phase, two-pole.
            ii. 2.25 kW for 240V ac, single-phase, two-pole.
            iii. 11.25 kW for 600V ac, three-phase, three-pole.

2.6 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Industrial Areas:

1. Material: Metal, specification grade, one-piece, 1 mm nominal thickness stainless steel.

2. Finish: ASTM A167, Type 302/304, satin.

3. Mounting Screw: Oval-head, finish matched to plate.

C. Weatherproof:

1. For Receptacles:

a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.

b. Mounting Screw and Cap Spring: Stainless steel.

2. For Switches:

a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.

b. Mounting Screw: Stainless steel.

c. Raised Sheet Metal: 12-7 mm high zinc-or cadmium-plated steel designed for one-piece drawn type sheet steel boxes.

d. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast metal boxes.

2.7 LIGHTING AND POWER DISTRIBUTION PANELBOARDS

A. Panelboards and Circuit Breakers: Suitable for use with 90 degrees Celsius wire at full OESC, 90 degrees Celsius ampacity.

B. Rating: Applicable to a system with available short-circuit current of 10,000 amperes rms symmetrical at 600 volts or 208 volts.

C. Fully rated, NEMA Type 1.

D. Ground Fault Circuit Interrupter (GFCI): 5 mA trip, 10,000 amps interrupting capacity circuit breakers.

E. Ground Fault Interrupter (GFI): 30 mA trip, 10,000-amp interrupting capacity circuit breaker, for heat tracing equipment.

F. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.

G. For each panel, provide five locks on devices.

H. Bus Bar:

1. Material: Tin-plated copper full sized throughout length.

2. Provide for mounting of future circuit breakers along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

3. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.

4. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.

5. Lugs and Connection Points:

    a. Suitable for either copper or aluminum conductors.

    b. Solderless main lugs for main, neutral and ground bus bars.

    c. Subfeed or through-feed lugs as shown on the Contract Drawings.

6. Bolt together and rigidly support bus bars and connection straps on molded insulators.

I. Circuit Breakers:

1. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.

2. Non-interchangeable.

3. Locking: Provisions for handle padlocking, unless otherwise shown on the Drawings.

4. Bolt-on circuit breakers in all panelboards.

5. Multi-pole circuit breakers designed to automatically open all poles when an overload occurs on one pole.

6. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.

7. Do not use tandem or dual circuit breakers in normal single-pole spaces.

8. Ground Fault Interrupter:

    a. Equip with conventional thermal-magnetic trip and ground fault sensor rated to trip in 0.025 second for a 5 mA ground fault (UL 943, Class A sensitivity).

    b. Sensor with same rating as circuit breaker and a push-to-test button.

J. Supply 600 V and 208/120 V panelboards from the same Manufacturer, except for hazardous areas.

2.8 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

A. Minimum Interrupt Rating**:** 25**,**000 amps rms symmetrical at 600 volts.

B. Thermal-magnetic, quick-make, quick-break, indicating type, showing ON/OFF and TRIPPED indicating positions of operating handle.

C. Suitable for use with 75 degrees Celsius wire at full OESC, 75 degrees Celsius ampacity.

D. Locking: Provisions for padlocking handle.

E. Multi-pole breakers to automatically open all poles when an overload occurs on one pole.

F. Enclosure: EEMAC Type as indicated in Part 3 of this Specification, unless otherwise shown on the Drawings.

G. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position.

H. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown on the Drawings.

2.9 NON-FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, Heavy-Duty (HD) Type with external markings clearly indicating ON/OFF positions, and where indicated in the Contract Documents, complete with early break auxiliary contacts.

C. Suitable for use with 75 degrees Celsius wire at full OESC, 75 degrees Celsius ampacity.

D. Unless indicated otherwise in the Contract Documents, enclosures shall be:

1. EEMAC 1A minimum.

2. EEMAC 3 outdoors.

E. Enclosure: EEMAC Type as indicated in Part 3 of this Specification unless otherwise shown on the Drawings.

F. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

2.10 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCHES

A. Contact Rating: NEMA ICS 2, Type A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Lights: LED Type, Push-to-test:

1. MOTOR RUNNING: Red.

2. MOTOR STOPPED: Green.

3. AMBER: Alarm.

4. VALVE OPEN: White.

5. VALVE CLOSED: Blue.

D. Pushbutton Colour:

1. MOTOR START: Black.

2. MOTOR STOP: Red.

3. VALVE OPEN: Black.

4. VALVE CLOSE: Blue.

E. Pushbuttons and selector switches lockable in OFF position where indicated in the Contract Documents.

F. Legend Plate:

1. Refer to Division 11.

2.11 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown on the Drawings.

B. Barrier between analog and digital signals.

C. Interior Finish: Paint with white enamel or lacquer.

D. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.

2. Spare Terminal Points: 25 percent.

2.12 TERMINAL BLOCK (0 TO 600 VOLTS)

A. Size components to allow insertion of necessary wire sizes.

B. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

C. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

D. Yoke, current bar and clamping screw of high strength and high conductivity metal.

E. Yoke shall guide all strands of wire into terminal.

F. Current bar shall ensure vibration-proof connection.

G. Terminals:

1. Capable of wire connections without special preparation other than stripping.

2. Capable of jumper installation with no loss of terminal or rail space.

3. Individual, rail mounted.

H. Marking system, allowing use of preprinted or field-marked tags.

2.13 MAGNETIC CONTROL RELAY

A. Application rated, with field convertible contacts.

B. Time Delay Relay Attachment:

1. Pneumatic Type, timer adjustable, time range as shown on the Drawings.

2. Field convertible from ON delay to OFF delay and vice versa.

C. Latching Attachment: Mechanical latch having unlatching coil and coil clearing contacts.

2.14 TIME DELAY RELAY

A. Industrial Relay Rated: 150 volts, 5 amps continuous, (3600 VA make, 360 VA break).

B. Solid-state electronic, field convertible from ON delay to OFF delay and vice versa.

C. One normally open and one normally closed contact (minimum).

D. Repeat accuracy plus or minus 2 percent.

E. Timer adjustment from 1 to 60 seconds, unless otherwise indicated on the Drawings.

2.15 RESET TIMER

A. Drive: Synchronous motor, solenoid operated clutch.

B. Mounting: Semiflush, panel.

C. Contacts: 10 amps, 120 volts.

2.16 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, non reset type.

C. Mounting: Semiflush, panel.

2.17 MANUAL MOTOR STARTERS

A. Manual Motor Starters: Single or multi-pole as indicated, quick-make, quick-break, manual reset, trip indicating handle, with one overload device in each ungrounded phase conductor, toggle operated.

B. Integral Horsepower Manual Motor Starter: EEMAC size M-1 minimum.

C. Enclosure: EEMAC 12 non-metallic.

2.18 MAGNETIC CONTACTOR

A. CSA/ ULC listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. NEMA B600 contacts.

2. Power driven in one direction with gravity dropout.

3. Silver alloy with wiping action and arc quenchers.

4. Continuous duty rated as indicated on the Drawings.

D. Control: As shown on the Drawings.

E. Contact configuration: As required on the Control Drawings.

F. Enclosure: EEMAC Type 4, unless otherwise shown on the Drawings.

2.19 DRY TYPE TRANSFORMER (0 TO 600 VOLT PRIMARY)

A. Windings: Copper, delta connected primary, wye connected secondary with neutral grounding provision.

B. Insulation Class and Temperature Rise: 185°C minimum with maximum 80°C temperature rise in 40 degrees Celsius ambient (epoxy encapsulated in damp hazardous or outdoor areas).

C. Core and Coil:

1. Thermosetting varnish impregnated for three-phase unit, 30 kVA and above.

D. Units larger than 5 kVA suitable for use with 75 degrees Celsius wire at full OESC, 75 degrees Celsius ampacity.

E. Enclosure:

1. Three-Phase, 30 kVA and Above: EEMAC Type 3R, ventilated.

2. Outdoor Transformers: EEMAC Type 3R.

F. Provide support(s) and anchorage to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for post-disaster structures.

G. Voltage Taps:

1. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

H. Impedance: 4.5 percent minimum on units 75 kVA and larger.

I. Maximum Sound Level: NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

J. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

2.20 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 Stainless Steel, 12-gauge.

E. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.

2. Fittings fabricated from Alloy 5052-H32.

F. Non-Metallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.

2. Channel fitting of same material as channel.

3. Nuts and bolts of long glass fiber reinforced polyurethane.

PART 3. EXECUTION

3.1 GENERAL

A. Install equipment in accordance with the Manufacturer's recommendations.

B. Use appropriate conduit and conductor entry fittings with enclosures to maintain the specified enclosure environmental capability after installation.

3.2 OUTLET AND DEVICE BOXES

A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet Ontario Electrical Safety Code requirements.

B. Size:

1. Depth: Minimum 51 mm, unless otherwise required by structural conditions. Box extensions not permitted.

   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.

2. Ceiling Outlet: Minimum 100 mm octagonal sheet steel device box, unless otherwise required for installed fixture.

3. Switch and Receptacle: Minimum 51 mm by 100 mm sheet steel device box.

C. Locations:

1. Drawing locations are approximate.

2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by the Consultant.

3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown on the Drawings.

4. Gas tight penetrations to be provided between wet well and MCC enclosure.

D. Identification

1. Provide lamicoid label at each light switch and receptacle showing associated circuit and lighting panel.

2. Provide lamicoid label at each local disconnect switch or breaker showing associated equipment and power source (Distribution Panel).

E. Mounting Height:

1. General:

a. Dimensions given to centerline of box.

b. Where specified heights do not suit building construction or finish, mount as directed by the Consultant.

2. Light Switch: 1200 mm above floor unless noted on Contract Drawing otherwise.

3. Convenience Receptacle:

a. General Interior Areas: 380 mm above floor.

b. Industrial Areas, Workshops: 1220 mm above floor.

c. Outdoor, All Areas: 610 mm above finished grade.

4. Switch Motor Starting: 1220 mm above floor, unless otherwise indicated on Drawings.

F. Install plumb and level.

G. Flush Mounted:

1. Install with concealed conduit.

2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.

3. Holes in surrounding surface shall be no larger than required to receive box.

H. Support boxes independently of conduit by attachment to building structure or structural member.

I. Install bar hangers in frame construction or fasten boxes directly as follows:

1. Wood: Wood screws.
2. Concrete or Brick: Bolts and expansion shields.
3. Hollow Masonry Units: Toggle bolts.
4. Steelwork: Machine screws.

J. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

K. Provide plaster rings where necessary.

L. Boxes embedded in concrete or masonry need not be additionally supported.

M. Install galvanized mounting hardware in industrial areas.

N. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

O. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

P. Open no more knockouts in sheet steel device boxes than are required, seal unused openings.

Q. Box Type (Steel Raceway System):

1. Exterior Locations:
    a. Exposed Raceways: Cast metal.
    b. Concealed Raceways: Cast metal.
    c. Concrete Encased Raceways: Cast metal.
    d. Class I, II, or III Hazardous Areas: Cast metal.
2. Interior Dry Locations:
    a. Exposed Rigid Conduit or IMC: Cast metal.
    b. Exposed EMT: Sheet steel.
    c. Concealed Raceways: Sheet steel.
    d. Concrete Encased Raceways: Cast metal.

e. Lighting Circuits, Ceiling: Sheet steel.

f. Class I, II, or III Hazardous Areas: Cast metal.

3. Interior Wet Locations:

a. Exposed Raceways: Cast metal.

b. Concealed Raceways: Cast metal.

c. Concrete Encased Raceways: Cast metal.

d. Lighting Circuits, Ceiling: Sheet steel.

e. Class I, II, or III Hazardous Areas: Cast metal.

4. Cast-In-Place Concrete Slabs: Sheet steel.

R. Box Type (Rigid Aluminum Raceway System): Cast aluminum.

S. Box Type (Non-metallic Raceway System):

1. Wet or Damp Locations: Non-metallic.

2. Corrosive Locations: Non-metallic.

3. Exposed Raceways: Non-metallic.

4. Concealed Raceways: Non-metallic.

5. Concrete Encased Raceways: Non-metallic**.**

T. Box Type, Corrosive Locations (PVC-Coated Rigid Galvanized Steel Raceway System): PVC-coated cast metal.

3.3 JUNCTION AND PULL BOXES

A. Install where shown on the Drawings and where necessary to terminate, tap-off, or redirect multiple conduits runs.

B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

D. Use outlet boxes as junction and pull boxes wherever possible and allowed by the OESC.

E. Use conduit bodies as junction and pull boxes where no splices are required, and their use is allowed by applicable codes.

F. Installed boxes shall be accessible.

G. Do not install on finished surfaces.

H. Install plumb and level.

I. Support boxes independently of conduit by attachment to building structure or structural member.

J. Install bar hangers in frame construction or fasten boxes directly as follows:

1. Wood: Wood screws.
2. Concrete or Brick: Bolts and expansion shields.
3. Hollow Masonry Units: Toggle bolts.
4. Steelwork: Machine screws.

K. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.

L. Boxes embedded in concrete or masonry need not be additionally supported.

M. At or Below grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain the Consultant's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

N. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

O. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

P. Location/Type:

1. Finished, Indoor, Dry: EEMAC Type 1.
2. Unfinished, Indoor, Dry: EEMAC Type 12.
3. Unfinished, Indoor and Outdoor, Wet: EEMAC Type 4.
    a. Steel Raceway System: Cast metal.
    b. Rigid Aluminum Raceway System: Cast aluminum.
4. Unfinished, Indoor and Outdoor, Wet and Corrosive: EEMAC Type 4X.
    a. PVC-Coated Rigid Galvanized Steel Raceway System: Non-metallic**.**
    b. Non-metallic Raceway System: Non-metallic.
5. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: EEMAC Type 13.
    a. Steel Raceway System: Cast metal.
    b. Rigid Aluminum Raceway System: Cast aluminum.
6. Unfinished, Indoor and Outdoor, Hazardous Class 1, Div. II: EEMAC Type 8.
    a. Steel Raceway System: Cast metal.
    b. Rigid Aluminum Raceway System: Cast aluminum.
7. Underground Conduit: Concrete.
8. Corrosive Locations: EEMAC Type 4X non-metallic.
9. Outdoor Locations Where Indicated Weatherproof (WP): EEMAC Type 3R, Outdoor.
10. Industrial Use in Areas Not Otherwise Classified: EEMAC Type 12, unless otherwise shown on the Drawings.

3.4 WIRING DEVICES

A. Switches:

1. Mounting Height: See Subsection 3.3, Outlet and Device Boxes.

2. Install with switch operation in vertical position.

3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Install with grounding slot down, except where horizontal mounting is shown on the Drawings.

2. Bond receptacles to boxes with grounding wire**.**

3. Weatherproof Receptacles:

   a. Install in cast metal box.

   b. Install such that hinge for protective cover is above receptacle opening.

4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

5. Special-Purpose Receptacles: Install in accordance with the Manufacturer’s instructions.

C. Multi-outlet Surface Raceway System:

1. Install in accordance with the Manufacturer’s instructions.

D. Switch, Motor Rated:

1. Install with switch operation in vertical position such that toggle is in up position when ON.

2. Install within sight of motor when used as a disconnect switch.

3. Mounting Height: See Subsection 3.3, Outlet and Device Boxes.

4. Enclosure Type: See Subsection 3.3, Outlet and Device Boxes.

3.5 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1.5 mm.

E. Types (Unless Otherwise Shown on the Drawings):

1. Exterior: Weatherproof.

2. Interior:

a. Surface Mounted, Metal Boxes**:**

1. General Purpose Areas: Sheet Steel.

2. Other Areas: Cast.

b. Surface Mounted, Aluminum Boxes:

1. General Purpose Areas: Stamped.

2. Other Areas: Cast.

c. Surface Mounted, Sheet Steel Boxes: Raised sheet steel.

d. Surface Mounted, Non-metallic Boxes**:** Manufacturer's standard.

3.6 PUSHBUTTON, INDICATING LIGHT AND SELECTOR SWITCH

A. Heavy-Duty, Oil-Tight Type: Locations (Unless Otherwise Shown on the Drawings): Nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Heavy-Duty, Watertight, and Corrosion-Resistant Type:

1. Locations (Unless Otherwise Shown on the Drawings): Nonhazardous, outdoor, or normally wet areas.

2. Mounting: EEMAC Type 4X Enclosure.

3.7 TERMINAL JUNCTION BOX

A. Install in accordance with Subsection 3.4, Junction and Pull Boxes.

B. Label each block and terminal with permanently attached non-destructible tag.

C. Do not install on finished outdoor surfaces.

D. Location/Type:

1. Finished, Indoor, Dry: EEMAC Type 1.
2. Unfinished, Indoor, Dry: EEMAC Type 12.
3. Unfinished, Indoor and Outdoor, Wet: EEMAC Type 4.
4. Unfinished, Indoor and Outdoor, Wet and Corrosive: EEMAC Type 4X.
5. Unfinished, Indoor and Outdoor, Wet, Dust, or Oil: EEMAC Type 13.

3.8 LIGHTING AND POWER DISTRIBUTION PANELBOARD

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 1830 mm above floor, unless otherwise shown on the Drawings.

C. Provide typewritten circuit directory for each panelboard.

D. Pad lockable.

E. Cabinet Location/Type:

1. General Use in Finished Areas: EEMAC Type 1.
2. Wet or Outdoor: EEMAC Type 4X.
3. Industrial Use in Areas Not Otherwise Classified: EEMAC Type 12, unless otherwise shown on the Drawings.

3.9 CIRCUIT BREAKER, FUSED SWITCH AND NONFUSED SWITCH ENCLOSURES

A. Location/Type:

1. Hazardous Gas, Class 1, Div I, Indoor: EEMAC Type 7.
2. Hazardous Dust, Class 1, Div II: EEMAC Type 9.

3. Wet: EEMAC Type 4.
4. Corrosive: EEMAC Type 4X.
5. Wet/Corrosive: EEMAC Type 4X.
6. Industrial Use: EEMAC Type 12.
7. General Purpose: EEMAC Type 1.
8. Where Denoted WP: EEMAC Type 3R.

3.10 DRY TYPE TRANSFORMER (0-TO-600-VOLT PRIMARY)

A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

B. Provide moisture-proof, flexible conduit for electrical connections.

C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

D. Pad-mounted, dead front, and tamperproof with all conductors entering and exiting from below.

E. Transformer shall meet test requirements of CSA C227.5.08 latest revision.

F. Provide complete test and inspection report.

G. Transformers installation and field testing will be performed by Electrical Contractor. Manufacturer Service Representative shall review the site installation and the results transformer testing done at site.

H. Provide certificate to indicate that the transformers have been installed according to the Manufacturer's Standards and is fit for energization.

3.11 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment and raceway systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:
    a. Aluminum Raceway: Extruded aluminum.

b. PVC-Coated Conduit: PVC coated.

c. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.

2. Interior, Corrosive (Wet or Dry) Locations:

a. Aluminum Raceway: Extruded aluminum.

b. PVC Conduit: Type 316 Stainless Steel or non-metallic.

c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 Stainless Steel, non-metallic, or PVC-coated steel.

3. Outdoor, Non-Corrosive Locations:

a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.

b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.

4. Outdoor Corrosive Locations:

a. PVC Conduit: Type 316 Stainless Steel or non-metallic.

b. Aluminum Raceway: Aluminum.

c. PVC-Coated Steel Conduit, and Other Systems Not Covered: Type 316 Stainless Steel, non-metallic, or PVC coated steel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.

2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.

3. Non-metallic Channel: Epoxy resin sealer.

4. PVC-Coated Channel: PVC patch.

3.12 INTRINSIC SAFETY BARRIERS

A. Installed in compliance with ISA-RP12.6.

B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.

C. Stencil “INTRISICALLY SAFE CIRCUIT” on all boxes including barriers.

3.13 SWITCHBOARD MATTING

A. Install 915 mm (36-inch) width at motor control center, and panelboards.

B. Matting shall run full length of all sides of equipment that have operator controls or afford access to devices.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. CSA-C22.2 No. 0.4 Bonding and Grounding of Electrical Equipment (Protective Grounding).

B. CSA-C22.2 No. 41 Grounding and Bonding Equipment.

C. IEEE No. 80 IEEE Guide for Safety in AC Substation Grounding.

D. IEEE No. 837 IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

1.2 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Shop Drawings: Product data for the following:

a. Exothermic weld connectors.

C. Submit PDF certified copies of field test results.

1.3 SOIL CONDITION

A. Prior to ordering ground rods, confirm that soil conditions will allow for a 3 m rod to be driven. When rock is present and preventing the use of ground rods, utilize copper grounding plates.

PART 2. PRODUCTS

2.1 GROUND ROD

A. Material: Copper.

B. Diameter: Minimum 19 mm.

C. Length: 3000 mm.

2.2 GROUND PLATE

A. Material: Copper.

B. Thickness: Minimum 1.6 mm.

C. Length x width: 600 x 600 mm.

D. Complete with 600 mm Pigtails.

2.3 GROUND CONDUCTORS IN CORROSIVE ENVIRONMENTS

A. Insulated or having tinned copper where in contact with aluminum or corrosive material, soil on atmosphere.

2.4 GROUNDING BUS IN ELECTRICAL ROOMS

A. Where indicated in the Contract Documents: Copper, minimum 50 mm cross-section or as indicated in the Contract Documents.

2.5 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.

2. Indoor Weld: Utilize low-smoke, low-emission process.

B. Compression Type:

1. Compress deforming type; wrought copper extrusion material.

2. Single indentation for Conductors 6 AWG and smaller.

3. Double indentation with extended barrel for Conductors 4 AWG and larger.

4. Barrels pre-filled with oxide-inhibiting and anti-seizing compound and sealed.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

2.6 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

PART 3. EXECUTION

3.1 GENERAL

A. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

B. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

C. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

D. Shielded Instrumentation Cables: Ground shields at each splice or termination in accordance with recommendations of the Splice or Termination Manufacturer.

E. Shielded Control Cables:

1. Ground shield to ground bus at power supply for analog signal.

2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.

3. Do not ground instrumentation cable shield at more than one point.

3.2 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 9.5 mm machine screws.

3.3 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Greater: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16 inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Greater: Tap motor frame or equipment housing; install solderless terminal with minimum 8 mm diameter bolt.

3.4 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown on the Contract Drawings.

C. Space multiple ground rods by one rod length.

3.5 GROUNDING WELLS

A. Install at asphalt, and paved areas.

B. Install riser ring and cover flush with surface.

C. Place 150 mm crushed rock in bottom of each well.

3.6 CONNECTIONS

A. General:

1. Above Grade Connections: Install compression-type connectors.

2. Below Grade Connections: Install exothermic weld or if connections are accessible compression type connectors are permitted.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal to-metal contact.

4. Notify the Consultant prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.

2. Use welding cartridges and molds in accordance with the Manufacturer's recommendations.

3. Avoid using badly worn molds.

4. Mold to be completely filled with metal when making welds.

5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with the Connector Manufacturer's recommendations.

2. Install connectors of proper size for grounding conductors and ground rods specified in the Contract Documents.

3. Install using the Connector Manufacturer's compression tool having proper sized dies.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.

2. Install in accordance with the Connector Manufacturer's recommendations.

3. Do not conceal mechanical connections.

3.7 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.8 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 100 to 150 mm above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.9 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

3.10 FIELD QUALITY CONTROL

A. As specified in Section 16080 – Electrical Testing.

END OF SECTION

PART 1. GENERAL

1.1 ACCEPTABLE TESTING AGENCY

A. Utilize the services of an independent group or agency specializing in the testing of medium and low voltage electrical equipment.

1.2 STANDARDS

A. The tests and inspections shall comply with NETA, International Electrical Testing Association and applicable AHJ requirements. Optional NETA tests are not required.

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Information Submittals:

1. Submit 30 Days prior to performing inspections or tests:
    a. Schedule for performing inspection and tests.
    b. List of references to be used for each test.
    c. Sample copy of equipment and materials inspection form(s).
    d. Sample copy of individual device test form.
    e. Sample copy of individual system test form.
2. Submit within 30 Days after completion of test.
3. Test or inspection reports and certificates for each electrical item tested.
4. Training Instructions, Operating and Maintenance Manuals:
    a. Submit Training Instructions in accordance with Section 01800.
    b. Submit Operating and Maintenance Manuals in accordance with Section 01330.
    c. After test or inspection reports and certificates have been reviewed by the Consultant and returned, insert a copy of each in Operation and Maintenance Manual.

1.4 QUALITY ASSURANCE

A. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA.

B. Test instrument calibration shall be in accordance with NETA.

1.5 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment are to be:

1. Scheduled with the Consultant prior to de-energization.

2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify the Consultant at least 48 hours prior to performing tests on energized electrical equipment.

1.6 UNIT RESPONSIBILITY

A. Testing agency to perform the inspections and tests and report the results.
The Contractor is to make repairs or modifications as per the Contract requirements, including the results of the electrical tests.

PART 2. PRODUCTS

2.1 TEST REPORTS

A. Provide all tests results with typed test reports and signed field test sheets.

B. All test sheets to include equipment nameplate data, customer identification, time and date of tests, environmental conditions during tests and test results.

PART 3. EXECUTION

3.1 GENERAL

A. Tests specified in this Section are to be performed in accordance with the requirements of Section 01800.

B. Tests and inspection shall establish that:

1. Electrical equipment is operational within Industry and Manufacturer's tolerances.

2. Installation operates properly.

3. Equipment is suitable for energization.

4. Installation conforms to requirements of Contract Documents and CEC, and ANSI C2.

C. Perform inspection and testing in accordance with NETA or ATS, Industry Standards, and Manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses and other applicable devices in accordance with values established by the short circuit and coordination study as specified in Section 16015 – Electrical Systems Analysis.

E. Adjust mechanisms and moving parts for free mechanical movement.

F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by the Manufacturer.

G. Verify nameplate data for conformance to the Contract Documents.

H. Realign equipment not properly aligned and correctly level.

I. Properly anchor electrical equipment foundation to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to Manufacturer's recommendations, or as otherwise specified in the Contract Documents.

K. Clean contaminated surfaces with cleaning solvents as recommended by the Manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform the Consultant of working clearances not in accordance with OESC.

N. Testing agency to investigate and report to the Consultant items as noted:

1. Electrical items that fail tests.
2. Active components not operating in accordance with Manufacturer's instructions.
3. Damaged electrical equipment.
4. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Contractor to repair or replace, as determined by the Consultant, door and panel sections having dented surfaces.
5. Contractor to repair or replace, as determined by the Consultant, poor fitting doors and panel sections.
6. Contractor to repair or replace improperly operating latching, locking, or interlocking devices.
7. Contractor to replace missing or damaged hardware.

P. If required due to extensive damage, as determined by the Consultant, the Contractor to refinish the entire assembly.

1. Test Equipment – General:
    a. Ensure suitable power supply is available for test equipment, be this 120VAC or battery powered devices. Record make, model, and calibration date of test instrument.
    b. All test equipment to have valid calibration stickers displayed on the equipment.
2. Insulation Resistance Meter (Megohmmeter/Megger):
    a. DC megger to have insulation scale to 20,000 Mega Ohms.
    b. Output voltages on DC megger units to be 250V, 500V, 1000V, 2500V and 5000V. Not all scales need to be available on each unit.

c. DC megger units to be suitable for 10 minute megger tests and polarization index tests.

d. Applied megohmmeter DC voltage in accordance with NETA ATS Table 7.1.1.

Q. DC High Pot Units:

1. Test instrument to have minimum output of 60 kV DC 16 mA capacity.

2. 120VAC powered.

3. Test to be conducted with full safety requirements in force, including “barrier” of conductor ends, proper bonding, “flag-person” as necessary.

R. AC High Voltage Units:

1. Use AC High voltage units for insulation tests and other tests as indicated in the Contract Documents, at voltage levels indicated, or required by Manufacturer’s recommendations.

2. Approved equipment is dobble test unit, or MultiAmp equivalent units.

S. Low Resistance Test Units (Ductor):

1. Low resistance test units to have 10A output.

2. Digital display and accuracy to 1 micro-ohm.

T. Relay Test Equipment:

1. Relay test equipment to be designed for relay testing, secondary current injection.

2. Current output to a minimum of 60Amps for testing of instantaneous features.

3. Indicators to detect open signals, pick-up signals and other required signals.

4. Timers to 1 millisecond.

5. MultiAmp or equivalent relay test units. Specifically designed relay testers for specific relays should be used if available.

6. For equipment required on three phase systems, have a three phase voltage and relay output test unit.

7. For equipment required on three phase differential tests, have a six phase voltage and relay output test unit.

U. Ground Resistivity Tester:

1. Ground resistivity tester to measure earth impedance in variable distances from the source to 250 meters.

2. Unit to be capable of plotting ground resistivity from 0.1 ohms and up.

V. Transformer Turns Ratio Test:

1. Three phase powered unit with solid state controls.

2. Unit capable of tests on multiple transformer winding configurations.

3. Single phase units may be used on specially wound transformers.

4. Turns ratio to 4 decimal place accuracy and display.

3.2 INSPECTION AND TESTS

A. Inspection and Tests – General:

1. The inspection and tests set out in this Section are supplementary to the inspection and tests specified in individual Sections of Electrical Equipment.

2. Conduct all production and routine tests as recommended in the ANSI and CSA Standards, preferably in the Manufacturer's facilities if possible.

3. Unless stated or agreed to otherwise, the tests described herein are tests to be repeated on Site as the minimum.

B. Preparatory Work of this Section:

1. Prior to beginning work of this Section on site submit for the Consultant's review, PDF copies of data sheets for testing and reporting as follows:

   a. List with descriptive literature of all test equipment to be used.

   b. Calibration certificates for the proposed test equipment.

   c. Test report forms to be used for each equipment type.

   d. Proposed work schedule.

2. Do not commence inspection and testing work before the above submissions are reviewed and agreed on.

3. The Contractor to provide all necessary supplementary lighting to permit careful inspection and testing. The supplementary lighting provided to be to the Consultant's prior agreement. During any Hydro shutdown the requirement for supplementary lighting to be increased to maintain an acceptable level of illumination.

4. Ensure Site conditions are satisfactory for execution of the work of this Section.

C. During Inspection and Testing:

1. Carry out the work of this Section with trained personnel, experienced in the particular type of testing and procedures required for each inspection and testing.

2. Ensure that any defects discovered are noted and corrected before continuing work of this Section.

3. As work of this Section progresses, maintain accurate records and submit to the Consultant for review when requested.

4. Mark any deviations found, initially on one set of the Drawings and Specifications on the site. Submit for the Consultant's review. Revise Drawings and mark-up Specifications if requested by the Consultant to ensure accuracy.

5. Revisions, further test results and clarifications of comments to be incorporated into the test reports.

6. The Contractor to record and report in detail any deficiencies rectified and repairs made during the course of the work of this Section as part of the test report.

D. Test Instruments – General:

1. Ensure suitable power supply is available for test equipment. Record make, model, and calibration date of test instrument.

E. Insulation Resistance Tests:

1. Use a megger with 20,000 M-ohm resolution for megger tests.

2. Record ambient temperature and adjust the measured M-ohms to 20 degrees Celsius (C) ambient.

3. Use 5 kV megger for 13.2 kV equipment, 2.5kV megger for 2.4 kV equipment and 1000 V megger range for power equipment of 600 V and below.

4. For 10-minute megger tests, record M-ohm values in/M-ohm at 30 seconds, 60 seconds, 5 minutes and 10 minutes. Plot M-ohm against time for each connection, calculate and record the ratio of measured M-ohm as follows:

a. 60 sec M-ohm/30 sec M-ohm = dielectric absorption.

b. 10 min M-ohm/1 min M-ohm = polarization index.

c. Report the 1-minute M-ohm as the insulation resistance value.

5. Submit tabulated measure M-ohm figures for 10-minute insulation tests, submit a graph.

F. D.C. High Voltage Test:

1. Conduct 10-minute insulation resistance test immediately before high voltage tests and submit test reports. Conduct High Voltage (H.V.) test only if the insulation resistance test result is satisfactory.

2. Test instrument to have minimum output of 60 kV DC 16 mA capacity.

3. Conduct test in accordance with IEEE Standard 400.

4. Compile test report.

5. Conduct H.V. test on switchgear (circuit breaker, transition unit and fuse-switch) before the power cable connections are made.

G. Test Results and Reporting – Data for Inclusion:

1. The following data to be included in the test report:

a. Equipment data with selected position, if applicable, e.g. transformer tap.

b. Protective devices make, model number, rating, as found settings. These to include C.T., V.T. relays, over-loads, fuses, breakers.

c. Adjustments, modifications and additions made on the equipment on Site, including fitting of new operating coils, with explanation of such work (necessity and method of execution).

d. A summary of conclusions of the inspection and testing.

e. The acceptable criteria and limiting values of measure figures by the Equipment Manufacturer. These to include the insulation resistance, (M-ohm) contact resistance (micro-ohm), leakage current (micro-ampere).

H. Test Results Completion:

1. Immediately after the inspection or testing work, submit PDF copies of handwritten preliminary reports with comments for the Consultant's review. Provide additional information or make revisions for clarity until deemed agreeable by the Consultant.

2. Final report to be submitted in typed form in PDF.

3. Photographs to be mounted on background sheet c/w labels. Curves and graphs to be neatly plotted on appropriate graph paper. Result tables to be typed and logically arranged.

I. Electrical Tests:

1. Insulation Resistance Tests:

   a. Applied megohmmeter DC voltage.

   b. Each phase of each bus section.

   c. Phase-to-phase and phase-to-ground for 1 minute.

   d. With switches and breakers open.

   e. With switches and breakers closed.

   f. Control wiring except that connected to solid state components.

   g. Insulation resistance values equal to, or greater than, ohmic values established by Manufacturer.

2. Current Injection Tests:

   a. Secondary injection for current flow of 1 ampere.

   b. Test current at each device.

3. Control Wiring:

   a. Apply secondary voltage to control power and potential circuits.

   b. Check voltage levels at each point on terminal boards and each device terminal.

4. Operational Test:

   a. Initiate control devices.

   B. Check proper operation of control system in each section.

3.3 LOW VOLTAGE MOTOR CONTROL CENTRES

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.

2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of draw out elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
    a. Closure attempt of device when door is in OFF or OPEN position.
    b. Opening attempt of door when device is in ON or CLOSED position.
8. Check key interlocking systems for:
    a. Key captivity when device is in CLOSED position.
    b. Key removal when device is in OPEN position.
    c. Closure attempt of device when key has been removed.
    d. Correct number of keys in relationship to number of lock cylinders.
    e. Existence of other keys capable of operating lock cylinders; destroy duplicate sets of keys.
9. Check nameplates for proper identification of:
    a. Equipment title and tag number with latest one-line diagram.
    b. Pushbutton.
    c. Control switches.
    d. Pilot lights.
    e. Control relays.
    f. Circuit breakers.
    g. Indicating meters.
10. Verify that fuse and circuit breaker sizes and types conform to the Contract Documents.
11. Verify that current and potential transformer ratios conform to the Contract Documents.

12. Check bus connections for high resistance by low resistance ohmmeter and thermographic survey:

    a. Ohmic value to be zero.

    b. Thermographic survey temperature gradient of 2 degrees Celsius, or less.

13. Check operation and sequencing of electrical and mechanical interlock systems by:

    a. Closure attempt for locked open devices.

    b. Opening attempt for locked closed devices.

    c. Key exchange to operate devices in OFF-NORMAL positions.

14. Verify performance of each control device and feature furnished as part of the motor control center.

15. Control Wiring:

    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.

    b. Check for proper conductor lacing and bundling.

    c. Check for proper conductor identification.

    d. Check for proper conductor lugs and connections.

16. Exercise active components.

17. Inspect Contactors for:

    a. Correct mechanical operations.

    b. Correct contact gap, wipe, alignment and pressure.

    c. Correct torque of all connections.

18. Compare overload heater rating with full-load current for proper size.

19. Compare fuse motor protector and circuit breaker with motor characteristics and power factor correction capacitors for proper size.

20. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter DC voltage.

b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.

d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.

e. Test values to comply with NETA ATS, Table 10.2.

2. Current Injection through overload unit at 300 percent of motor full-load current and monitor trip time:

a. Trip time in accordance with Manufacturer's published data.

b. Investigate values in excess of 120 seconds.

3. Control Wiring Tests:

a. Apply secondary voltage to control power and potential circuits.

b. Check voltage levels at each point on terminal boards and each device terminal.

c. Insulation resistance test at 1,000 volts DC on control wiring except that connected to solid state components.

1. Insulation resistance to be 1 megohm minimum.

4. Operational test by initiating control devices to affect proper operation.

3.4 MEDIUM VOLTAGE CABLES, 28 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:

a. Physical damage plus jacket and insulation condition.

b. Proper connections in accordance with single-line diagram.

c. Proper shield grounding.

d. Proper cable support.

e. Proper cable termination.

f. Cable bends not in conformance with Manufacturer's minimum allowable bending radius.

g. Proper arc and fireproofing in common cable areas.

h. Proper circuit and phase identification.

2. Mechanical Connections For:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with Manufacturer's recommendation.

3. Conductors Terminated Through Window Type CTs: Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Utilize 2,500-volt megohmmeter for 5 kV conductors.

b. Test each cable individually with remaining cables and shields grounded.

c. Test each conductor with respect to ground and to adjacent conductors in accordance with IEEE 118 procedures for 1 minute.

d. Evaluate ohmic values by comparison with conductors of same length and type.

e. Investigate values less than 50 megohms.

2. Shield Continuity Tests:

a. By ohmmeter method on each section of conductor.

b. Investigate values in excess of 10 ohms per 300 metres of conductors.

3. High Potential DC Tests:

a. In accordance with Manufacturer's recommendations.

b. Each conductor section tested with:

1. Splices and terminations in-place but disconnected from equipment.

2. Remaining conductors and shields grounded in accordance with IEEE 400.

c. Apply maximum dc test voltage of 25 kV for 5 kV, 100 percent and 133 percent insulation conductor.

d. Measure only the leakage current associated with conductor.

e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.

f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48 or Manufacturer's Specifications.

g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.

1. Increments not to exceed AC voltage rating of conductor.

2. Record DC leakage current at each step after a constant stabilization time consistent with system charging current.

h. Raise conductor to specified maximum test voltage and hold for 15 minutes, or as specified by Conductor Manufacturer. Record DC leakage current at 30 seconds and 1 minute and at 1-minute intervals, thereafter.

i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.

j. Test results evaluated on a pass/fail basis.

3.5 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed Power Cable No. 4 and larger for:

a. Physical damage.

b. Proper connections in accordance with single-line diagram.

c. Cable bends not in conformance with Manufacturer's minimum allowable bending radius where applicable.

d. Colour coding conformance with the Specifications.

e. Proper circuit identification.

2. Mechanical Connections for:

a. Proper lug type for conductor material.

b. Proper lug installation.

c. Bolt torque level in accordance with Manufacturer's recommendation.

3. Shielded Instrumentation Cables for:

    a. Proper shield grounding.

    b. Proper terminations.

    c. Proper circuit identification.

4. Control Cables For:

    a. Proper termination.

    b. Proper circuit identification.

5. Cables terminated through window type Current Transformers (CTs): Verify that neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 4 and larger:

1. Insulation Resistance Tests:

    a. Utilize 1,000-volt DC megohmmeter for 600 volt insulated conductors.

    b. Test each conductor with respect to ground and to adjacent conductors per IEEE 118 procedures for 1 minute.

    c. Evaluate ohmic values by comparison with conductors of same length and type.

    d. Investigate values less than 50 megohms.

2. Continuity test by ohmmeter method to ensure proper cable connections.

3.6 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.

2. Proper operation of switch operating handle.

3. Adequate mechanical support for each fuse.

4. Proper contact-to-contact tightness between fuse clip and fuse.

5. Cable connection bolt torque level in accordance with NETA, Table 10.1.

6. Proper phase barrier material and installation.

7. Verify that fuse sizes and types correspond to one-line diagram.

8. Perform mechanical operational test and verify electrical interlocking system operation and sequencing.

B. Electrical Tests:

1. Insulation Resistance Tests:

a. Applied megohmmeter DC voltage.

b. Phase-to-phase and phase-to-ground for 1 minute on each pole.

c. Insulation resistance values equal to, or greater than, ohmic values established by the Manufacturer.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each switch blade and fuse holder.

b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.7 MOULDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 400 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.

2. Proper conductor size.

3. Feeder designation according to nameplate and one-line diagram.

4. Cracked casings.

5. Connection bolt torque level in accordance with Manufacturer's recommendation.

6. Operate breaker to verify smooth operation.

7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.

8. Verify that terminals are suitable for 75 degrees Celsius rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:

a. Utilize 1,000-volt DC megohmmeter 600 volt circuit breakers.

b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:

a. Contact resistance in microhms across each pole.

b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Primary Current Injection Test to verify:

a. Long-time minimum pickup and delay.

b. Short-time pickup and delay.

c. Ground fault pickup and delay.

d. Instantaneous pickup by run-up or pulse method.

e. Trip characteristics of adjustable trip breakers shall be within Manufacturer's published time-current characteristic tolerance band, including adjustment factors.

3.8 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper mounting, cell fit, and element alignment.

2. Proper operation of racking interlocks.

3. Check for damaged arc chutes.

4. Proper contact condition.

5. Bolt torque level in accordance with Manufacturer's recommendations.

6. Perform mechanical operational and contact alignment tests in accordance with the Manufacturer's instructions.

7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.

8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.

9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.

10. Check operation of electrically operated breakers in accordance with the Manufacturer's instructions.

11. Check for adequate lubrication on contact, moving, and sliding surfaces.

B. Electrical Tests:

1. Insulation Resistance Tests:

   a. Utilize 1,000-volt dc megohmmeter 600 volt circuit breakers.

   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.

   d. Test values to comply with NETA ATS, Table 10.2.

2. Contact Resistance Tests:

   a. Contact resistance in microohms across each pole.

   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.

3. Secondary Current Injection Test to verify:

   a. Long-time minimum pickup and delay.

   b. Short-time pickup and delay.

   c. Ground fault pickup and delay.

   d. Instantaneous pickup by run-up or pulse method.

   e. Trip characteristic when adjusted to setting sheet parameters shall be within Manufacturer's published time-current tolerance band.

3.9 PROTECTIVE RELAYS

A. Visual and Mechanical Inspection:

1. Visually check each relay for:

a. Tight cover gasket and proper seal.

b. Unbroken cover glass.

c. Condition of spiral spring and contacts, if applicable.

d. Disc clearance, if applicable.

e. Condition of case shorting contacts if present.

2. Mechanically check each relay for:

a. Freedom of movement.

b. Proper travel and alignment.

c. Trip plunger mechanism.

3. Verify that each relay:

a. Complies with the Contract Documents and the designated application.

b. Is set in accordance with recommended settings.

B. Electrical Tests:

1. Insulation resistance test on each circuit to frame except for solid state devices.

2. Tests on nominal recommended setting for:

a. Pickup parameters on each operating element.

b. Timing at three points on time-current curve.

c. Pickup target and seal-in units.

d. Special tests as required to check operation of restraint, directional, and other elements in accordance with Manufacturer's instruction manual.

3. Phase angle and magnitude contribution tests on differential and directional relays after energization to vectorially verify proper polarity and connections.

4. Current Injection Tests:

a. For entire current circuit in each section.

b. Secondary injection for current flow of 5 ampere.

c. Test current at each device.

5. For Motor protection Relays and similar relays, use 3-phase current injection for unbalanced protection testing, unless recommended otherwise by the Manufacturer.

3.10 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential and control transformers for:

   a. Cracked insulation.

   b. Broken leads or defective wiring.

   c. Proper connections.

   d. Adequate clearances between primary and secondary circuit wiring.

2. Verify mechanically that:

   a. Grounding and shorting connections have good contact.

   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:

   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts DC for 30 seconds.

   b. Polarity test.

2. Potential Transformer Tests:

   a. Insulation resistance test at test voltages for 1 minute on:

      1. Winding-to-winding.

      2. Winding-to-ground.

   b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 7.1.1.

3.11 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify that meter types and scales conform to the Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.12 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard, switchboard, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control center, panelboard, switchboard, and assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that moulds were fully filled, and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
    a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
    b. Main ground electrode system resistance to ground to be no greater than 3 ohms.
2. Two-Point Direct Method Test:
    a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
    b. Equipment ground resistance shall not exceed main ground system resistance by 0.5 ohm.

3.13 GROUND FAULT SYSTEMS

A. Inspection and Testing limited to:

1. Zero sequence grounding systems.

2. Residual ground fault systems.

B. Visual and Manual Inspection:

1. Neutral main bonding connection to ensure that:

   a. Zero sequence sensing system is grounded ahead of neutral disconnect link.

   b. Ground strap sensing system is grounded through sensing device.

   c. Neutral ground conductor is solidly grounded.

2. Verify that control power has adequate capacity for system.

3. Manually operate monitor panels for:

   a. Trip test.

   b. No trip test.

   c. Nonautomatic rest.

4. Zero sequence system for symmetrical alignment of core balance transformers about current carrying conductors.

5. Relay check for pickup and time under simulated ground fault conditions.

6. Verify nameplate identification by device operation.

C. Electrical Tests:

1. Test system neutral insulation resistance with neutral ground link removed. System neutral insulation resistance minimum 1 megohm.

2. Determine relay pickup by primary current injection at the sensor. Relay pickup current within plus or minus 10 percent of device dial or fixed setting.

3. Test relay timing by injecting 300 percent of pickup current, or as specified by Manufacturer. Relay operating time in accordance with Manufacturer's time-current characteristic curves.

4. Test system operation at 55 percent rated control voltage, if applicable.

5. Test zone interlock system by simultaneous sensor current injection and monitoring zone blocking functions.

3.14 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 50 hp and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
    e. Excessive vibration.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 10.2 for:
        1. Motors above 200 hp for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
        2. Motors 200 hp and less for 1-minute duration with resistances tabulated at 30 and 60 seconds.
    b. Insulation resistance values equal to, or greater than, ohmic values established by Manufacturers.
2. Calculate polarization index ratios for motors above 200 hp. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.

3. Insulation resistance test on insulated bearings in accordance with the Manufacturer's instructions.

4. Measure running current and voltage and evaluate relative to load conditions and nameplate full-load amperes.

3.15 LOW VOLTAGE SURGE ARRESTORS

A. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.

2. Ground connections to ground bus.

B. Electrical Tests:

1. Varistor Type Arrestors:

a. Clamping voltage test.

b. Rated RMS voltage test.

c. Rated dc voltage test.

d. Varistor arrestor test values in accordance with ANSI C62.33, Sections 4.4 and 4.7.

3.16 THERMOGRAPHIC SURVEY

A. Provide a thermographic survey of connections associated with incoming service conductors, bus work and branch feeder conductors 250 mcm and larger at each:

1. Medium voltage switchboard.

2. Tranformers.

3. Medium and low voltage motor control center.

4. Panelboard.

B. Provide a thermographic survey of Feeder Conductors No. 2 and larger terminating at:

1. Motors rated 50 hp and larger.

2. Disconnect switches.

C. Remove necessary enclosure metal panels and covers prior to performing survey.

D. Perform with equipment energized during periods of maximum possible loading.

E. Do not perform survey on equipment operating at less than 20 percent of rated connected operating load.

F. Utilize thermographic equipment capable of:

1. Detecting emitted radiation.

2. Converting detected radiation to visual signal.

3. Detecting 1 degree Celsius temperature difference between subject area and reference point of 30 degrees Celsius.

G. Temperature gradients of:

1. 3 degrees Celsius to 7 degrees Celsius indicates possible deficiency that warrants investigation.

2. 7 degrees Celsius to 15 degrees Celsius indicates a deficiency that is to be corrected at the Contractor's earliest opportunity.

3. 16 degrees Celsius and above indicates a deficiency that is to be corrected immediately.

H. Provide written report of:

1. Areas surveyed and the resultant temperature gradients.

2. Locations of areas having temperature gradients of 3 degrees Celsius or greater.

3. Cause of heat rise, and actions taken to correct the cause of heat rise.

4. Detected phase unbalance.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1. ASTM A82/A82M-05a, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A185/A185M-05a, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
3. ASTM C139-05, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
4. ASTM D1056-00, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
5. ASTM C150-07, Standard Specification for Portland Cement.
6. ASTM C33, Standard Specification for Concrete Aggregates.
7. ASTM C857 – 14, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
8. ASTM F593 – 17, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

B. Canadian Standards Association (CSA International)

1. CAN/CSA-A3000-03(R2005), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
2. CSA-A3001-03, Cementitious Materials for Use in Concrete.
3. CSA A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
4. CAN/CSA-G30.18-M92 (R2002), Billet-Steel Bars for Concrete Reinforcement.
5. G40.20-04/G40.21-04 (R2009) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

C. American National Standards Institute (ANSI).

1. SCTE 77-2010, Specification for Underground Enclosure Integrity.

D. Health Canada/Workplace Hazardous Materials Information System (WHMIS)

1. Safety Data Sheets (SDS).

1.2 STORAGE

A. Packing, shipping, handling and unloading:

1. Deliver, store and handle materials in accordance with Division 1.

2. Deliver, store and handle materials in accordance with Manufacturer's written instructions.no extra cost to the City, replace cables to the satisfaction of the Contract Administrator.

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Product Data:

1. Submit Manufacturer's printed product literature, Specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

2. Submit one (1) copy WHMIS – Safety Data Sheets (SDS) in accordance with Division 1.

C. Shop Drawings:

1. Precast manholes.

D. Quality Assurance Submittals: Submit following in accordance with Section 01400.

1. Test Reports: Submit certified test reports for specified materials from approved independent testing laboratories, indicating compliance with Specifications for specified performance characteristics and physical properties.

2. Certificates: Submit certificates signed by Manufacturer certifying that materials comply with specified performance characteristics and physical properties.

PART 2. EXECUTION

2.1 PVC DUCTS

A. Rigid type PVC ducts, Schedule 40, as indicated to CSA-C22.2, with moulded fittings.

2.2 PVC DUCT FITTINGS

A. Rigid PVC opaque solvent welded type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.

B. Expansion joints.

C. Rigid PVC 5° angle couplings

D. Rigid PVC 90° and 45 ° bends.

2.3 CONCRETE ENCASED MANHOLES

A. Precast concrete manholes and auxiliary sections fabricated in steel forms.

B. Aggregates: To CSA-A23.1/A23.2.

C. Portland Cement: To CAN/CSA-A3000-A5, Type 10.

D. Steel Welded Wire Fabric Mesh Reinforcing: To CSA-G30.3.

E. Pulling inserts and bolts for racks integrally cast in concrete.

F. Neoprene Gasket Seals between Manhole Sections: To ASTM D1056.

2.4 DRAINAGE

A. Floor drain fittings in each manhole consisting of floor drain, back water valve, trap and pipe connection to drainage system.

B. Storm Sewer Connection: Cast iron service saddle consisting of oil resistant gasket, stainless steel clamp and oil resistant O ring.

C. Sump Pit: 300 x 300 x 125 mm.

2.5 FRAMES AND COVERS

A. Cast iron manhole frames and covers.

B. Bolted on covers to prevent unauthorized entry.

2.6 GROUNDING

A. Ground rods in accordance with Section 16317.02 – Grounding.

2.7 CABLE RACKS

A. Hot dipped galvanized cable racks and supports.

.2 12 x 100 mm preset inserts for rack mounting.

2.8 CABLE PULLING EQUIPMENT

A. Pulling Iron: Galvanized steel rods, size and shape as indicated.

B. Pull Rope: 6 mm stranded nylon polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

2.9 MARKERS

A. Provide 150 mm wide, 4 mil, polyethylene marker tape in all trenches. Use red colored tape. Install at depth as per Drawings.

2.10 ACCESSORIES

A. All bolts, studs, screws, nuts, washers and other fastening material shall be stainless steel and shall be according to ASTM F593.

PART 3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with Manufacturer's written recommendations or Specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION GENERAL

A. Install underground duct banks and manholes including formwork.

B. Build duct bank and manholes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density or as noted on Contract Drawings.

C. Open trench completely between manholes before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.

D. Prior to laying ducts, construct "mud slab" not less than 75 mm thick.

E. Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.

F. Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.

G. Lay PVC ducts with configuration as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically.

1. Stagger joints in adjacent layers at least 150 mm and make joints watertight.

H. Make transpositions, offsets and changes in direction using 5-degree bend sections, do not exceed a total of 20 degree with duct offset.

I. Install base spacers at maximum intervals of 900 mm levelled to grades indicated for bottom layer of ducts.

J. Allow concrete to attain 50% of its specified strength before backfilling.

K. Use bell ends at duct terminations in manholes/handholes or buildings.

L. Use conduit to duct adapters when connecting to conduits.

M. Terminate duct runs with duct coupling.

N. Seal ducts at both ends using CSA Approved sealants to avoid ingress of foreign material.

O. Cut, ream and taper end of ducts in field in accordance with Manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.

P. Install four 3 m lengths of 15M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire rods to 10M dowels at manhole or building and support from duct spacers.

Q. Use anchors, ties and trench jacks as required to secure ducts.

1. Tie ducts to spacers with twine or other non-metallic material.

R. Clean Ducts before Laying:

1. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.

S. Duct Cleaning:

1. Pull 300 mm long x diameter 6 mm less than internal diameter of duct steel mandrel through each duct, immediately after placing.

2. Then pull stiff bristle brush through duct; avoid disturbing or damaging ducts.

3. Pull stiff bristle brush through each duct immediately before pulling-in cables.

T. In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.

3.3 MANHOLES

A. Install Precast Manholes:

1. Install ground rod, inserts for pulling irons, drain, duct outlets, duct run dowels. Make manhole/handholes to duct connection as indicated.

B. Install manhole frames and covers for each manhole.

C. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 12.7-mm sieve to 4.75-mm sieve and compacted to same density as adjacent undisturbed earth.

D. Drain floor towards drainage source with 1 to 48 slope minimum and install drainage fittings as indicated.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Ensure filling of voids in joint being sealed.

G. Plaster with cement grout, walls, ceiling and neck.

H. Spray paint "X" on ceiling of manhole/handhole above floor drain or sump pit.

I. Waterproofing: Apply waterproofing to exterior surfaces of handholes. Waterproofing materials and installation are specified in Division 7. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars.

3.4 MARKERS

A. 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.

B. Mark ducts every 150 m along straight runs and changes in direction.

C. Where markers are removed to permit installation of additional duct, reinstall existing markers.

D. Lay concrete markers flat and centered over duct with top 25 mm above earth surface.

E. Provide Drawings showing locations of markers.

3.5 FIELD QUALITY CONTROL

A. Inspections:

1. Inspection of duct will be carried out by City Representative prior to placing.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. CSA-C22.2 No. 131 Type TECK 90 Cables.
2. CAN/CSA-C61089, Round Wire Concentric Lay Overhead Electrical Stranded Conductors.
3. CSA-C22.2 No. 38 Thermoset Insulated Wires and Cables.
4. CSA-C68.10.
5. ICEA S-93-639/NEMA WC74, 5-46 KV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.
6. CSA-C68.3 Power Cables with Thermoset Insulation.
7. CSA-C21.1 600 V Control Cable.
8. CSA-C21.2 300 V Control Cable.

1.2 DESIGN REQUIREMENTS

A. Number and sizes of wires (and associated raceways) indicated are a guide only and are not necessarily the exact number and sizes required. Wire or cable sizes smaller than indicated are not acceptable.

B. Coordinate with Greater Sudbury Hydro Inc. for 12kV overhead ACSR Standards.

C. Unless otherwise indicated, combine motor or electric heater branch power wiring (below 1000 V systems) and associated local operator control or field control device wiring into a common conduit between motor or heater and its starter or motor control centre, as per latest edition of O.E.S.C., provided all of the following conditions are met:

1. Motor circuit voltage does not exceed 600 V.
2. Conductors and termination fittings for power and control circuits are rated 600 V minimum.
3. Control circuits are designed to operate at 120 V AC or higher. Install wiring for control circuits operating below 100 V AC or with DC in a separate conduit system.

4. Control circuit wiring solely associated with respective motor or heater. Install wiring for control circuits of other equipment and systems or wiring common to two or more pieces of equipment in separate conduits.

D. Supply spare conductors in control, communication and instrumentation cable circuits as follows:

1. Up to four utilized conductors in one conduit or cable: One spare conductor.

2. Five to eight utilized conductors in one conduit or cable: Two spare conductors.

3. Nine or more utilized conductors: 20 percent or three spare conductors, whichever is greater.

1.3 STORAGE

A. Cap cable ends to prevent water penetration into cable. Reseal after cutting length of cable.

B. Cables stored with ends unsealed will be immediately removed from site at Contractor's cost. At no extra cost to the City, replace cables to the satisfaction of the Contract Administrator.

1.4 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings:

1. Wire and cable descriptive product information.

2. Wire and cable accessories descriptive product information.

1.5 CSA COMPLIANCE

A. Materials manufactured within scope of Canadian Standards or acceptable equivalent shall conform to UL Standards and have an applied CSA listing mark.

PART 2. EXECUTION

2.1 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to requirements of applicable CSA Standards.

B. Conductor Type:

1. 120- and 208-Volt Lighting, No. 12 AWG: Solid copper.

2. 120-Volt Receptacle Circuits, No. 12 AWG: Solid copper.

3. All Other Circuits: Stranded copper.

C. Low Voltage Wire and Cable (1000 V and Below):

1. Construction: Stranded, annealed copper conductors, 600 V minimum rating for #14, #12 and #10 AWG and 1000 V rating for conductors larger than #10 AWG, RW90 Cross-Linked Polyethylene (XLPE) Insulation, suitable for handling at minus 40 degrees C ambient, 90 degrees C maximum conductor temperature, limited flame spread FT4. RWU90 for underground installation.

2. Standard: CSA-C22.2 No. 38.

3. Minimum Conductor Sizes: Unless otherwise indicated, #12 AWG for power and current transformer circuits; #14 AWG for control circuits and fire alarm circuits; #16 AWG for PA circuits; telephone wiring to comply with Telephone Utility Standards.

4. Lighting Wiring: GTF wire, 600 volt, 125 degrees C, flexible copper conductor for connections between luminaire and outlet boxes.

5. Colour Coding: For insulated conductors, conform to the following:

a.	1-Conductor Power	-	Black (Phase Conductors)
		-	White (Neutral)
b.	1-Conductor Control	-	Red
c.	2-Conductor Power	-	Black, White
d.	3-Conductor Power	-	Red, Black, White (Neutral)
		-	Red, Black, Blue
e.	4-Conductor Power	-	Red, Black, Blue, White

D. Low Voltage Armoured Wire and Cable (1000 V and Below):

1. Construction: Stranded, annealed copper conductors, 1000 V rating, RW90 Cross-Linked Polyethylene (XLPE) Insulation, suitable for handling at minus 40 degrees C ambient, 90 degrees C maximum conductor temperature, flame test rated FT4.

2. Power Cabling: TECK construction.

3. Control Cabling: TECK construction.

4. Lighting and Receptacle Branch Wiring in Wet Well: TECK construction.

5. Minimum Conductor Size: Unless otherwise indicated, #12 AWG for power and current transformer circuits and #14 AWG for control and fire alarm circuits.

6. Grounding Conductor: Stranded, soft, bare copper conductor in multiconductor cables, concentric copper wires over insulation in single conductor cable.

7. Multi-Conductor Cables: With inner jacket of suitable PVC (minus 40 degrees C).

8. Interlocking Armour: Flexible, galvanized steel or aluminum for multi-conductor cables and aluminum for single conductors, spirally wound over inner jacket.

9. Outer Jacket: PVC (minus 40°C), flame-retardant, FT4 flame test rated, low acid gas evolution, black outer jacket extruded over the armour.

10. Wiring to be rated for hazardous location type indicated on Contract Drawings.

11. Colour Coding: For insulated conductors, conform to the following:

a.	1-Conductor Power	-	Black
b.	1-Conductor Control	-	Red
c.	2-Conductor Cable	-	Black, White
d.	3-Conductor Cable	-	Red, Black, White (Neutral)
		-	Red, Black, Blue
e.	4-Conductor Cable	-	Red, Black, Blue, White
f.	Multi-Conductor Cables	-	Manufacturer's Standard

E. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.

2. Conform to physical and minimum thickness requirements of NEMA WC 8.

2.2 PRIMARY OVERHEAD CONDUCTORS

A. ACSR Bare, aluminum, steel reinforced conductors to CSA-C49.1, size as indicated.

2.3 CONCENTRIC NEUTRAL POWER CABLE

A. Concentric Neutral Power Cable: To ANSI/NEMA WC 74-2012/ICEA S-3-639.

B. Single copper conductor, size as indicated.

C. Semi-conducting extruded shield.

D. Class 2 compact round.

E. Insulation: TRXLPE rated 90^{o}C and 15KV for 100% voltage.

F. Semi-conducting insulation shielding layer.

G. Copper neutral wires applied helically over insulation shield equivalent to 133% full capacity.

H. Separator tape over neutral wires.

I. Extruded PVA jacket rated -40^{o}C.

2.4 RX CABLE FOR VFD APPLICATIONS

A. Drive Rx cables shall be copper conductor with 1000 volt insulation rating and include three grounds and have an aluminum sheath continuously corrugated and have a PVC jacket.

B. Drive Rx cabling shall comply with CSA Standard C22.2 No. 123-96 (R001).

2.5 INSTRUMENTATION AND FIBRE OPTIC CABLE

A. Instrumentation cables as per Division 13.

2.6 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Wiring Accessories:

1. Wire Markers: Plastic slip-on, black letters on white background.

2. Cable Markers: For cables or conductors greater than 13 mm diameter, strap-on type, semi rigid PVC carrier strip.

3. Terminal Blocks: 600 V, 25 A minimum rating, modular, 35 mm DIN rail mounted, provision for circuit number labelling, individually removable, sized to accommodate conductor size and circuit current.

4. Field Wiring Terminations: Where screw-type terminal blocks are provided, supply insulated fork tongue terminals.

5. Splice Connectors for Equipment Pig-Tail, Lighting and Receptacle Circuits: For Wire Sizes #12 and #10 AWG inclusive, twist-on compression spring type.

6. Moisture and Waterproofing: In wet locations, with Liquid Tape by Ideal.

7. Equipment Pig-Tail Power Circuit Connections: For Wire Sizes #8 AWG minimum, split-bolt type, sized to suit number and size of conductors.

8. Underground Splices: Not allowed.

9. Low Voltage (1000 V and lower) Motor Terminations: Heat shrinkable connection kit, including sleeves, caps and sealant.

10. Cable Ties: Nylon, one-piece, self-locking type.

11. TECK Cable Connectors in Wet or Outdoor Areas: Watertight type.

12. Electrical Insulating Tape: Scotch 33 by 3M Canada Inc.

13. Cable Grips: To accommodate type and geometry of cable supported, single weave, variable mesh design.

B. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.

2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.

3. Arc and Fireproofing:

   a. 30-mil, elastomer.

C. Identification Devices:

1. Sleeve: Permanent, PVC, yellow or white, with legible machine-printed black markings.

2. Heat Bond Marker:

   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.

b. Self-laminating protective shield over text.

c. Machine printed black text.

3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

4. Tie-On Cable Marker Tags:

a. Chemical resistant white tag.

b. Size: 12 mm by 50 mm.

5. Grounding Conductor: Permanent green heat-shrink sleeve, 50 mm minimum.

D. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.

E. Heat Shrinkable Insulation:

1. Thermally stabilized, crosslinked polyolefin.

2.7 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Termination Kits:

1. Capable of terminating single-conductor cables.

2. Capable of producing a termination with a current rating equal to, or greater than, the cable ampacity, meeting Class 1 requirements of IEEE 48.

3. Capable of accommodating any form of cable shielding or construction without the need for special adapters and/or accessories.

B. Bus Connection Insulation:

1. Heat shrinkable tubing, tape, and sheets of flexible crosslinked polymeric material formulated for high dielectric strength.

2. Tape and sheet products to have coating to prevent adhesion to metal surfaces.

3. Insulating materials to be removable and reusable.

C. High Voltage (above 1000 V) Cable Terminations: Engineered termination kits, rated for conductor number, size and voltage class of cable, heat shrinkable type, stress relieving, with heat activated sealant. Supply outdoor skirts for outdoor terminations.

D. Cable Lugs:

1. In accordance with NEMA CC1.

2. Rated 5 kV of same material as conductor metal.

2.8 WARNING TAPE

A. As specified in Section 16050 – Basic Electrical Materials and Methods.

2.9 SOURCE QUALITY CONTROL

A. Conductors 600 Volt and Below: Test in accordance with UL 44 and 854 Standards.

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 8 and AEIC CS 6 partial discharge level test for EPR insulated cable.

PART 3. EXECUTION

3.1 GENERAL

A. Conductor storage, handling, and installation to be in accordance with Manufacturer's recommendations.

3.2 CABLE INSTALLATION UNDERGROUND OR IN DUCT BANKS

A. Provide an installation plan and procedure, complete with cable pulling calculations to ensure that maximum pulling tensions and side wall pressures do not exceed cable Manufacturer's recommendations, to the Consultant within 30 working days prior to pulling any cables.

B. Provide input and advice to the construction of the duct banks and manholes as needed, including through attendance at a pre-duct bank construction meeting.

C. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

D. Install overhead cable on pole lines as indicated and in accordance with Manufacturer's instructions.

E. Install power cable in ducts and manholes as indicated and in accordance with Manufacturer's instructions.

F. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

G. Terminate all conductors and cables, unless otherwise indicated.

H. Tighten screws and terminal bolts in accordance with UL 486A for copper conductors.

I. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

J. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

K. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 6 mm smaller than raceway inside diameter.

L. Install stress cones, terminations and splices in accordance with Manufacturer's instructions.

M. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.
2. Separate cables of different voltage rating in same cable tray with barriers.
3. Fasten wires and cables to tray with nylon cable straps at the following maximum intervals:
    a. Horizontal Runs: 6000 mm.
    b. Vertical Runs: 1500 mm.

3.3 CIRCUIT IDENTIFICATION

A. Circuits Appearing in Circuit Schedules: Identify power, instrumentation, and control conductor circuits, using circuit schedule designations, at each termination and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes and terminal boxes.

B. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

C. Method:

1. Conductors No. 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors No. 2 AWG and Larger:
    a. Identify with marker plates.
    b. Tie-on cable marker tags.
    c. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.4 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits. Provide 10 AWG for circuit length more than 25 meters.

B. Do not splice incoming service conductors and branch power distribution conductors.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of Power Circuit Conductors No. 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and Power Circuit Conductors No. 4 AWG through No. 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for Power Circuit Conductors No. 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on Motor Circuit Conductors No. 10 AWG and larger.
7. Tape insulate all uninsulated connections.
8. Place no more than one conductor in any single-barrel pressure connection.
9. Install crimp connectors with tools approved by Connector Manufacturer.
10. Install terminals and connectors acceptable for type of material used.

11. Compression Lugs:

    a. Attach with a tool specifically designed for purpose.

    b. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.

    c. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Terminations:

1. Indoors: Use general purpose, flame retardant tape.

2. Outdoors: Use flame retardant, cold- and weather-resistant tape.

F. Cap spare conductors and conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.

2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. General:

    a. Avoid running cables inside or under power cable trays. Where field wiring is in power cable trays, insulation must be equal to or greater than the highest voltage in the cable tray.

    b. Where power or signal cables must cross, make them cross at an angle of 90 degrees.

    c. Communication cables will not be mixed with power or signal cables.

2. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.

3. Terminate with methods consistent with terminals provided, and in accordance with Terminal Manufacturer's instructions.

4. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 1800 mm of extra conductor in freestanding panels and minimum 600 mm in other assemblies.

J. Signal Separation:

1. Analog and 24 VDC Discrete Signals: Analog 4-20 mA signals and 24 Vdc discrete signals should normally be in separate conduits. An exception to this standard may be made in cases where it would cause parallel conduit runs to the same device and combining signals would eliminate one conduit. In cases where the exception is used, both the analog and discrete signals should be twisted shielded pairs as described for analog signals previously. This exception will be limited to 3 meters only.

2. AC Digital and Control: AC digital signals and AC control wiring may occupy the same conduit, but all instrument power circuits should be isolated by a separate conduit from all AC digital and control circuits.

3. All signal cables shall be installed in rigid, liquid-tight, metallic conduit with the last meter of flexible conduit to the field instrument.

K. Miscellaneous

1. Thermocouple Extension Wire: Thermocouple extension circuits should be solid conductors and same gauge as the T/C of the same material as the associated thermocouple. Thermocouple signal lines should be continuous from the thermocouple connection head to the final termination point.

2. Spare Conductors: Spare conductors in each conduit should be equal to 15 percent of the number required for both present and (defined) future conditions, but in no case less than two spare wires or one pair, should be installed. Each cable should have 10 percent spare conductors but not less than two conductors. Spare conductors should be terminated on a marked terminal strip or connector pin at each end.

3. Termination: Wire at both ends of the cable should be terminated with pre-insulated solderless spade or ring lugs for maximum physical strength and electrical conduction. Wires should not be terminated on adjacent terminal points if accidental short-circuiting could cause tripping or closing of a breaker.

4. Colour Coding: Cables or conductors may require colour coding to suit process requirement.

5. Connect Ethernet port of each network node to the designated Ethernet wall-outlet located in the termination closet using Ethernet patch cable.

3.5 CABLE INSTALLATION IN DUCTS

A. Install cables as indicated in ducts.

B. Do not pull spliced cables inside ducts.

C. Install multiple cables in duct simultaneously.

D. Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

E. To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.

F. Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.

G. After installation of cables, seal duct ends with duct sealing compound.

3.6 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by the Contract Administrator.

B. Install terminals or connectors acceptable for type of conductor material used.

C. Provide shield termination and grounding for all terminations.

D. Perform Hi-Pot and insulation resistance tests of the cables and their termination. The Hi-Pot test will be to CSA Standards and to the satisfaction of ESA.

E. Provide necessary mounting hardware, covers, and connectors.

F. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for instrumentation, control, and Power Circuit Conductors No. 4 AWG through No. 2/0 AWG.

2. Install uninsulated, bolted, two-way connectors and terminators for Power Circuit Conductors No. 4/0 AWG and larger.

3. Install uninsulated, bolted, two-way connectors for Motor Circuit Conductors No. 12 and larger.

4. Insulate bus connections with heat shrinking tubing, tape, and sheets.

3.7 FIELD QUALITY CONTROL

A. In accordance with Section 16080 – Electrical Testing.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 16010 – Electrical General Requirements.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. CSA-C22.2 No. 40-M-1989 (R2009 or latest revision), Cutout, Junction and Pull Boxes.

2. CSA-C22.2 No. 94.2-07 (R2012 or latest revision), Enclosures for Electrical Equipment, Environmental Considerations (Tri-National Standard, with NMX-J-235/2-ANCE-2007 and UL 50E).

3. CSA-C22.2 No. 178.2-04 (R2014 or latest revision) – Requirements for Manually Operated Generator.

1.3 SUBMITTALSS

A. Submit submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Submit to the Consultant prior to commencement of the work, the following:

a. Shop Drawings including the following information.

b. Manufacturer's descriptive literature, Specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

c. Drawing stamped and signed by Professional Engineer licensed to practice in the Province of Ontario.

PART 2. PRODUCTS

2.1 JUNCTION AND PULL BOXES

A. Welded steel construction with screw-on flat covers for surface mounting.

B. Covers with a minimum 25 mm extension all around, for flush-mounted pull and junction boxes.

C. Must be watertight.

D. To be explosion proof for hazardous area.

2.2 CONTOL PANEL ENCLOSURE

A. Approved Suppliers:

1. Hammond Manufacturing Company Limited.
2. Ralston Metal Products Limited.
3. Rittal System Ltd.
4. Pentair Inc. (Hoffman).
5. Approved Equivalent.

PART 3. EXECUTION

3.1 INSTALLATION

A. Junction, Pull Boxes Installation:

1. Install junction and pull boxes in accordance with CSA-C22.2 No. 40-M-1989 (R2009 or latest revision), Cutout, Junction and Pull Boxes.

2. Install enclosures in accordance with CSA-C22.2 No. 94.2-07 (R2012 or latest revision), Enclosure for Electrical Equipment, Environmental Considerations (Tri-National Standard, with NMX-J-235/2-ANCE-2007 or latest revision and UL 50E).

3. Install pull boxes in inconspicuous but accessible locations as shown on the Contract Drawings or as approved by the Consultant.

4. Mount cabinets with top a maximum of 2 m above the finished floor.

5. Only main junction and pull boxes indicated on the Contract Drawings. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes as approved by the Consultant.

B. Identification:

1. Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

C. Commissioning:

1. All inspection and testing activities shall be completed in accordance with the commissioning plan that shall be provided to the Consultant prior to the start of commissioning activities.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. This Section applies only when referenced by a Motor-Driven Equipment Specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and any deviations from this Section will be listed in the Equipment Specification. Where such deviations occur, they shall take precedence over this Section.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. CSA-C22.2 No. 100, Motors and Generators.
2. CSA-C22.2 No. 145, Motors and Generators for Use in Hazardous Locations.
3. CSA-C390, Energy Efficiency Test Methods for Three-Phase Induction Motors.
4. American Bearing Manufacturers Association (ABMA):
    a. 9, Load Ratings and Fatigue Life for Ball Bearings.
    b. 11, Load Ratings and Fatigue Life for Roller Bearings.
5. Institute of Electrical and Electronics Engineers Inc. (IEEE):
    a. 85, Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.
    b. 112, Standard Test Procedures for Polyphase Induction Motors and Generators.
    c. 114, Standard Test Procedures for Single-Phase Induction Motors.
6. National Electrical Manufacturers Association (NEMA):
    a. MG 1, Motors and Generators.
    b. MG 13, Frame Assignments for Alternating Current Integral Horsepower Induction Motors.
    c. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. Ontario Electrical Safety Code current edition (OESC).

8. EEMAC Standard M1-6, Motors and Generators.

9. EEMAC Standard MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.

1.3 DEFINITIONS

A. CISD-TEFC: Chemical Industry, Severe-Duty Enclosure.

B. EXP: Explosion-Proof Enclosure.

C. ODP: Open Drip-Roof Enclosure.

D. TEFC: Totally Enclosed, Fan Cooled Enclosure.

E. TENV: Totally Enclosed, Non-Ventilated Enclosure.

F. WPI: Open Weather Protected Enclosure, Type I.

G. WPII: Open Weather Protected Enclosure, Type II.

H. Motor Nameplate Kilowatt (Horsepower): That rating after any de-rating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

I. Inverter Duty Motor: Motor meeting all applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

1.4 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Shop Drawings:

a. Descriptive information.

b. Nameplate data in accordance with NEMA MG 1.

c. Additional Rating Information:

1. Service factor.

2. Locked rotor current.

3. No load current.

4. Safe stall time for motors 225 kW and larger.

5. Multi-speed load classification (e.g., variable torque).

6. Variable frequency drive motor load classification (e.g., variable torque) and minimum allowable motor speed for that load classification.

7. Guaranteed minimum full load efficiency and power factor.

c. Enclosure type and mounting (e.g., horizontal, vertical).

d. Dimensions and total weight.

e. Conduit box dimensions and usable volume as defined in NEMA MG 1 and OESC.

f. Bearing type.

g. Bearing lubrication.

h. Bearing life.

i. Space heater voltage and watts.

j. Description, ratings, and Wiring Diagram of motor thermal protection.

k. Motor sound power level in accordance with NEMA MG 1.

l. Maximum brake horsepower required by the equipment driven by the motor.

m. Description and rating of submersible motor moisture sensing system.

n. The Contractor shall provide equipment supports and anchorage to meet the requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.

C. Information Submittals:

1. Factory test reports, certified for motors 225 kW and larger. For motors smaller than 225 kW, standard factory test reports.

D. Training Instructions, Operating and Maintenance Manuals.

1. Submit Training Instructions in accordance with Section 01800.

2. Submit Operating and Maintenance Manuals in accordance with Section 01330.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. U.S. Electrical Motors.

B. Toshiba International Corp.

C. TECO-Westinghouse Motor Co.

D. GE Canada.

2.2 GENERAL

A. All motors shall be energy efficient "NEMA Premium" design and meet the minimum efficiency requirements listed in Tables 1 of NEMA MG 1.

B. For multiple units of the same type of equipment, furnish identical motors and accessories of a single Manufacturer.

C. In order to obtain single source responsibility, utilize a single Supplier to provide a drive motor, its driven equipment, and specified motor accessories.

D. Meet the requirements of NEMA MG 1.

E. Frame assignments in accordance with NEMA MG 13.

F. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

G. Lifting lugs on all motors weighing 45 kg or more.

H. Operating Conditions:

1. Maximum ambient temperature is 40 degrees Celsius (C), unless indicated otherwise in the Contract Documents. For this case see Item 2.8.4 of this Section.

2. Motors shall be suitable for operating conditions without any reduction being required in the nameplate rated horsepower or exceeding the rated temperature rise.

3. Overspeed in either direction in accordance with NEMA MG 1.

2.3 HORSEPOWER RATING

A. As designated in the Applicable Motor-Driven Equipment Specifications.

B. Constant Speed Applications: Brake horsepower of the driven equipment at any operating condition is not to exceed motor nameplate horsepower rating, excluding any service factor.

C. Variable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition is not to exceed motor nameplate kilowatt (horsepower) rating, excluding any service factor.

2.4 SERVICE FACTOR

A. 1.15 minimum at rated ambient temperature, unless otherwise indicated in the Contract Documents.

B. 1.0 for motors used in VFD applications.

2.5 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in the Individual Motor-Driven Equipment Specifications:

Size	Voltage	Phases
0.375 kW and smaller	120	1
0.5 kW through 225 kW	600	3
Greater than 225 kW	4160	3

C. Suitable for full voltage starting.

D. 112.5 kW and larger also suitable for solid state reduced voltage starting.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.6 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 0.75 kW, multi-speed, short time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:

    a. Tested in accordance with CSA-C390, Paragraph 12.59.

    b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 1 Supplement, or as indicated in the Motor-Driven Equipment Specifications.

2. Power Factor: Guaranteed minimum at full load in accordance with NEMA MG 1 Table 1 Supplement or as indicated in the Motor-Driven Equipment Specifications.

2.7 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 Tables. Not applicable to motors operated on VFDs.

B. Safe stall time 10 seconds or greater when motor is at ambient conditions.

2.8 INSULATATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's Standard winding insulation system.

B. Motors Rated over 600 Volts: Sealed VPI form wound windings in accordance with NEMA MG 1.

C. Three-Phase and Integral Horsepower Motors: Unless otherwise indicated in the Motor-Driven Equipment Specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP motors which must be Class B with Class B rise.

D. For motors operating above 40°C ambient conditions, motors shall be designed with a maximum temperature rise of 80°C by resistance method, without any reduction of nameplate ratings.

2.9 ENCLOSURES

A. Enclosures shall conform to NEMA MG 1.

B. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet requirements for Class I, Zone 1 or 2 (as required in the application), Group C and D Hazardous locations.

2. Drain holes with drain and breather fittings.

3. Integral thermostat opening on excessive motor temperature in accordance with OESC.

4. Terminate thermostat leads in terminal box separate from main terminal box.

D. Submersible: In accordance with Subsection 2.16, Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for all motors.

B. Diagonally split, cast iron, rotatable to each of four 90 degree positions. Threaded hubs for conduit attachment.

C. Furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19:

Terminal Box Usable Values		
Voltage	**Kilowatt Rating**	**Percentage**
600	11 through 93.5	500
600	112.5 through 225	275
4160	> 225	200

E. Terminal for connection of equipment grounding wire in each terminal box.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 0.5 kW and Smaller: Permanently lubricated and sealed ball bearings or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

2. 0.7 kW through 300 kW: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.

3. Above 300 kW: Regreasable antifriction bearings in labyrinth sealed end bells with removable grease relief plugs.

4. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and 11.

B. Vertical Motors:

1. Thrust Bearings:

   a. Antifriction Plate Type (Kingsbury) bearing.

   b. Manufacturer's Standard Lubrication 75 kilowatt and smaller.

   c. Minimum 50,000 hours L-10 bearing life.

2. Guide Bearings:

   a. Manufacturer's Standard Bearing Type.

   b. Manufacturer's Standard Lubrication 150 kilowatt and smaller.

   c. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.

2. Readily accessible, removable grease relief plugs.

D. Bearing Isolation: Motors rated for inverter duty shall have electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with IEEE 85 and NEMA MG 1.

B. Motors controlled by variable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.

2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. External Finish: Prime and finish coat Manufacturer's Standard.

C. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting the requirements for Guarded Machine in NEMA MG 1 and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermistors:

a. Motors for constant speed application 30 kW and larger.

b. Thermistor embedded in each stator phase winding before winding dip and bake process.

c. In intimate contact with winding conductors.

d. Epoxy-potted, solid state thermistor control module mounted in NEMA 250, Type 4X box on motor by Motor Manufacturer.

e. Automatic reset contacts rated 120 volts AC, 5 amps minimum, opening on excessive temperature.

f. Individual thermistor circuits factory-wired to control module.

g. Control module rated for 120V ac power supply.

2. RTDs:

a. Refer to Contractor Drawings for details.

C. Nameplates:

1. Raised or stamped letters on stainless steel.

2. Display motor data required by NEMA MG 1, Paragraphs 10.39 and 10.40 in addition to bearing numbers for both bearings.

3. Nameplate must have "NEMA Premium" designation.

4. Premium efficiency motor nameplates to also display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

D. Anchor Bolts: The Contractor shall provide anchor bolts meeting the Manufacturer's recommendations and of sufficient size and number for the specified seismic conditions.

2.16 SPECIAL MOTORS

A. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the Motor-Driven Equipment Specifications.

B. Inverter Duty Motor:

1. Motor supplied power by adjustable voltage and variable frequency drives shall be inverter duty rated.

2. Motor shall be suitable for operation over entire speed range indicated in the Contract Documents.

3. Provide forced ventilation where speed ratio is greater than published range for motor being installed.

C. Submersible Pump Motor:

1. At 100 Percent Load:

Submersible Pump Motors		
Horsepower	**Guaranteed Minimum Efficiency**	**Guaranteed Minimum Power Factor**
5 through 10	80	82
10.1 through 50	85	82
50.1 through 100	87	82
Over 100	89	82

2. Insulation System: Manufacturer's Standard Class B or Class F.

3. Motor capable of running dry continuously.

4. Enclosure:

a. Hermetically sealed, watertight, for continuous submergence up to 20 metres depth.

b. Listed to meet OESC requirements for Class I, Zone 1 and 2 Group C and D Hazardous atmosphere.

c. Seals: Tandem mechanical.

5. Bearing and Lubrication:

a. Permanently sealed and lubricated, replaceable antifriction guide and thrust bearings.

b. Minimum 15,000 hours L-10 bearing life.

6. Inrush kVA/horsepower no greater than NEMA MG 1 and Code F Rating.

7. Winding Thermal Protection:

   a. Thermal sensor and switch assembly, one each phase, embedded in stator windings and wired in series.

   b. Switches normally closed, open upon excessive winding temperature, and automatically reclose when temperature has cooled to safe operating level.

   c. Switch contacts rated at 5 amps, 120V AC.

8. Motor Seal Failure Moisture Detection:

   a. Probes or sensors to detect moisture beyond seals.

   b. Probe or sensor monitoring module for mounting in motor controller, suitable for operation from 120V AC supply.

   c. Monitoring module with control power transformer, probe test switch and test light, and two independent 120V AC contacts, one opening and one closing when the flux of moisture is detected.

9. Bearing over temperature protection for motors larger than 100 horsepower:

   a. Sensor on lower bearing housing monitoring bearing temperature.

   b. Any monitoring relay necessary to provide 120V AC contact opening on bearing over temperature.

10. Winding thermal protection, moisture detection, and bearing over temperature specified above may be monitored by a single device providing two independent 120V ac contacts, one closing and one opening on malfunction.

11. Connecting Cables:

    a. Two separate cables, one containing power and grounding conductors, and the other containing control and grounding conductors.

    b. Each cable suitable for hard service, submersible duty with watertight seal where cable enters motor.

    c. Length: 10 metres minimum.

    d. CSA listed and sized in accordance with OESC.

12. Rotor when motor is in inclined position.

13. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

D. Inclined Motors:

1. Motors suitable for operation only in horizontal position not acceptable.

2. Bearings designed for thrust imposed by driven equipment and by motor rotor when motor is in inclined position.

3. Lubrication system designed to provide adequate bearing lubrication when motor is in inclined position.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with CSA-C390 for polyphase motors and for single-phase motors.

2. Routine (production) tests on all motors in accordance with NEMA MG 1, plus no load power at rated voltage and polyphase, rated voltage measurement of locked rotor current.

3. For premium efficiency motors, test efficiency at 50, 75, and 100 percent of rated kilowatts:

   a. In accordance with CSA-C390 or IEEE 112, Test Method B, and NEMA MG 1, Paragraphs 12.59 and 12.60.

   b. For motors 375 kW and larger where facilities are not available to test by Dynamometer (Test Method B), Determine Efficiency by CSA-C390 or IEEE 112, Test Method F.

4. Power Factor:

   a. Speed.

   b. Current at rated kilowatts.

   c. kW input at rated load.

   d. On motors of 75 kW and smaller, furnish a certified copy of a motor efficiency test report on an identical motor.

5. Vibration (balance).
    a. Test Report Forms.
6. Routine Tests: IEEE 112, Form A-1.

PART 3. EXECUTION – NOT APPLICABLE

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 16010 – Electrical General Requirements.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

2. CSA-C22.2 No. 0.4-04, Bonding Electrical Equipment (Protective Grounding).

1.3 SUBMITTALS

A. Submit submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Product Data:

a. Provided Manufacturer's printed product literature, Specifications, data sheet and include product characteristics, performance criteria, physical size, finish and limitations.

b. Manufacturer's Written Instructions: Submit Manufacturer's written instructions and special handling criteria, installation sequence and cleaning procedures.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle materials in accordance with Manufacturer's written instructions.

PART 2. PRODUCTS

2.1 MATERIALS

A. Rod Electrodes: Copper clad steel, 19 mm diameter by 3 m long.

B. Plate Electrode: Copper surface area 2 m^2, 2 mm thick.

C. Conductors: Bare, stranded, untinned soft annealed copper wire, Size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors and ground connections.

D. Conductors: PVC insulated coloured green, stranded untinned soft annealed copper wire, Size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards and potential transformers.

E. Conductors: PVC insulated coloured green, stranded untinned soft annealed Copper Wire No. 10 AWG for grounding meter and relay cases.

F. Conductors: No. 3/0 AWG extra flexible (425 strands) copper conductor for connection of switch mechanism operating rod to gradient control mat, fence gates and vault doors.

G. Bolted removable test links.

H. Gradient Control Mat: Copper, size 1.8 x 1.2 m, 50 x 50 mm mesh and 2 mm thick.

I. Accessories: Non-corroding, necessary for complete grounding system, type, size material as indicated, including:

1. Grounding and bonding bushings.
2. Protective type clamps.
3. Bolted type conductor connectors.
4. Thermit welded type conductor connectors.
5. Bonding jumpers, straps.
6. Pressure wire connectors.

J. Wire Connectors and Terminations: As indicated.

PART 3. EXECUTION

3.1 GROUNDING INSTALLATION

A. Install continuous grounding system including, electrodes, conductors, connectors and accessories in accordance with CSA-C22.2 No.0.4 and requirements of local authority having jurisdiction.

B. Ground fences to grounding system independent of station ground.

C. Install connectors in accordance with Manufacturer's written instructions.

D. Protect exposed grounding conductors from mechanical injury.

E. Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermit process.

F. Use mechanical connectors for grounding connections to equipment provided with lugs.

G. Use No. 4/0 AWG bare copper cable for main ground bus of substation and No. 2/0 AWG bare copper cable for taps on risers from main ground bus to equipment.

H. Use tinned copper conductors for aluminum structures.

I. Do not use bare copper conductors near un-jacketed lead sheath cables.

3.2 ELECTRODE INSTALLATION

A. Install ground rod or plate electrodes, as indicated. Make grounding connections to station equipment.

B. Install ground rod electrodes at transformer location.

C. Install gradient control mats. Connect mats to station ground electrode and switch mechanism operating rods.

D. Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

3.3 EQUIPMENT GROUNDING

A. Install grounding connections as indicated to typical station equipment including metallic water main, line sky wire, neutral, gradient control mats. Noncurrent carrying parts of transformers, generators, motors, circuit breakers, current transformers, frames of gang-operated switches and fuse c. out bases. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. Sub-station fences, pothead bodies. Outdoor lighting.

B. Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.

C. Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station. Make connections to metallic water pipes outside station to assist in reduction of station ground resistance value.

3.4 NEUTRAL GROUNDING

A. Connect transformer neutral (where present) and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.

B. Interconnect electrodes and neutrals at each grounding installation.

C. Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.

D. Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to ground test link.

3.5 POLE MOUNTED SWITCHING DEVICE GROUNDING

A. Drive four ground rods 3 m long at base of each pole on which group-operated line switching devices are mounted.

B. Arrange rods in square formation with 3 m sides, located so that operator must stand within square to operate switch.

C. Interconnect ground rods with No. 2/0 AWG stranded annealed copper conductor and join to switch operating handle ground wires.

D. Connect operating handle of switch to handle base with No. 3/0 AWG extra flexible copper conductor.

3.6 GROUNDING IN MANHOLES

A. Install system and equipment grounding in manhole in accordance with Section 16060.

3.7 CABLE SHEATH GROUNDING

A. Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables.

B. Use No. 6 AWG flexible copper wire soldered, not clamped, to cable sheath.

C. Connect bonded cables to ground with No. 2/0 AWG copper conductor.

3.8 FIELD QUALITY CONTROL

A. Perform tests in accordance with Section 16010.

B. Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Engineer of Record and local authority having jurisdiction.

C. Perform test before energizing electrical system.

D. Engage testing agent to inspect grounding and perform resistance test before backfilling.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. CAN/CSA-C22.2 No. 4-[04(R2009)], Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).

B. CSA-C22.2 No. 39-[13], Fuseholder Assemblies.

1.2 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Submit the Manufacturer's data for all disconnect switches.

C. Identify the motor or equipment served by each switch on each nameplate inscription.

D. Submit PDF certified copies of field test results.

PART 2. PRODUCTS

2.1 DISCONNECT SWITCHES

A. Supply and install safety switches, fused or non-fused, as required complete with fuses as shown on the Contract Drawings or required by Ontario Electrical Code. Safety switches shall be quick make and quick break construction with safety interlock and kW (hp) ratings as indicated in the Contract Documents.

B. Fusible and non-fusible, disconnect switch in CSA Enclosure type rated for given location and size as indicated in the Contract Documents.

C. Provision for padlocking in off switch position by three locks.

D. Mechanically interlocked door to prevent opening when the handle is in the ON position.

E. Fuses: On load side of switch size as indicated in the Contract Documents.

F. Fuse Holders: Re-locatable and suitable without adaptors, for type and size of fuse indicated in the Contract Documents.

G. Quick-make, quick-break action.

H. ON-OFF switch position indication on switch enclosure cover.

I. For switches 100A and over, provide non-tracking arc shrouds.

J. Supply neutral bar.

K. Provide ground bar for ground termination.

L. Provide dry auxiliary contact interlocked with switch mechanism.

M. Approved Suppliers:

1. Schneider Canada Inc.
2. Eaton Industries (Canada) Company
3. Siemens
4. Approved Equivalent.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install disconnect switches complete with fuses if applicable as indicated on the Contract Drawings.

3.2 COMMISSIONING

A. All inspection and testing activities shall be completed in accordance with the commissioning plan that shall be provided to the Consultant prior to the start of commissioning activities.

END OF SECTION

PART 1. GENERAL

1.1 SUMMARY

A. New 600V Motor Control Center.

B. Provide permanent viewing windows to safely allow diagnostic infrared scanning without opening MCC doors/covers. Provide windows as required to scan all critical components and connections in each cell. Ensure that the windows are suitable for usage in 600V indoor equipment. The window shall be made of glass-like material that is transparent to infrared rays. The viewing window shall have a minimum diameter of 50 mm and shall meet the following requirements:

1. UV sensitivity is NONE.
2. Coatings is NONE.
3. Temperature Tolerance minimum 100 degrees Celsius.
4. Window to withstand a minimum pressure of 58 PSI.

C. Coordination

1. Coordinate with VFD Suppliers for the installation and connection of new VFDs.

1.2 REFERENCES

A. EEMAC/NEMA Standard ICS 2.

B. CAN/CSA-C22.2 No. 14 Industrial Control Equipment.

C. The following is a list of standards which may be referenced in this Section:

1. American National Standard Institute (ANSI):
    a. C2, National Electrical Safety Code (NESC).
    b. C57.12.28, Switchgear and Transformers-Pad-Mounted Equipment-Enclosure Integrity.
2. National Electrical Manufacturers Association (NEMA):
    a. AB1, Molded Case Circuit Breakers.

b. ICS 1, General Standards for Industrial Control and Systems.

c. ICS 2, Standards for Industrial Control Devices, Controllers, and Assemblies.

d. ICS 2.3, Instructions for Handling, Installation, Operation, and Maintenance of Motor Control Centers.

e. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

f. 250, Enclosures for Electrical Equipment (1,000 volts maximum).

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings: To be noted on the Drawings:

1. Itemized bill of material.
2. Descriptive information.
3. Dimensional Drawings.
4. Conduit entrance locations.
5. Bus data.
6. Protective Devices: Copies of time-current characteristics.
7. Details of supports and anchorage provided to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.
8. Typed Tabulation:
    a. Motor name tag (equipment) numbers as shown on the Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Heater catalog number.
    f. Protective device trip settings.

9. Attach above typed, tabulated data to a copy of starter Manufacturer's overload heater selection tables for the starters provided.

10. Control Diagrams:

    a. NEMA ICS 2, Section 322.08 Type II.

    b. Wiring Type B.

11. One-Line Diagrams.

12. Schematic (elementary) Diagrams. Must also show and identify all remote devices and in addition to PDF copies, provide electronic copies in AutoCAD format.

13. Outline Diagrams.

14. Interconnection Diagrams.

C. Training Instructions, Operating and Maintenance Manuals.

1. Submit Training Instructions in accordance with Section 01800 – Training.

2. Submit Operating and Maintenance Manuals in accordance with Section 01330 – Submittals. Maintenance Manuals to include but not limited to the following:

    a. Complete parts list.

    b. Spare parts list.

    c. Installation instructions.

    d. Operating instructions.

    e. Maintenance instructions.

    f. Detailed troubleshooting procedures and fault correction schedules.

    g. Final Record Drawings.

    h. Disc with electronic copies of the Drawings.

    i. Certified test results.

D. Prior to shipping the MCC, submit comprehensive Starter Wiring Diagrams showing wiring between panel components and devices and panel terminal blocks and between panel terminal blocks and remote equipment.

E. Submit Final Record Wiring Diagrams at completion of the Contract. Include changes made during field installation and start-up. Enclose one copy of the Wiring Diagram in a plastic envelope and leave in each starter compartment door pocket.

1.4 CSA COMPLIANCE

A. Products manufactured shall conform to CSA Standards and have an applied CSA or equivalent approved listing mark.

1.5 QUALITY ASSURANCE

A. Factory test individual components and complete MCC assembly in accordance with the Applicable Standards referred to above.

B. The Manufacturer is to notify the Consultant a minimum of two (2) working days prior to tests.

C. Test MCC assembly in accordance with the Applicable Standards above and include, but do not limit to, the following items:

1. Interchangeability of removable elements.

2. Mechanical and electrical operation of circuit breakers, starters, draw out mechanism, interlocks, auxiliary switches, protective devices, manual devices.

3. Functional tests on components and circuits. Simulate control signals.

4. Continuity of power and control circuit wiring.

1.6 PACKING AND SHIPPING

A. Shipping splits established by the Contractor to facilitate ingress of equipment to final installation location within the building.

1.7 VARIABLE FREQUENCY DRIVES (VFD)

A. Refer to Section 16485 for details of MCC section mounted VFD drives.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Allen Bradley.

B. Eaton/Cutler-Hammer.

C. Schneider Electric.

2.2 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 2, CSA C22.2 No. 14, and UL 845.
2. Voltage Rating: A: 600 volts.
3. Short Circuit Rating: 35,000A Interrupting Capacity. To be verified and confirmed as per Section 16015 – Electrical System Analysis.
4. All controllers, main and branch circuit breakers, wire connections, and other devices to be front mounted and accessible unless otherwise noted in the Contract Documents.
5. Supports and anchorage to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.
6. NEMA ICS 2, Section 322.08:
    a. Class: IIS.
    b. Type: B.
    c. Wire remote control and signal circuits to separate terminal board compartment in each motor control centre lineup.
7. Provide blank spaces on Interconnection Diagrams to add control conductor code designations during installation of equipment.

B. Enclosure:

1. Modular, compartmented vertical sections, rigid, free-standing, dead-front, metal enclosed.

2. Type: 1, gasketed.

3. Vertical Section Dimensions: Per Contract Drawings.

4. Construction:

   a. Sheet steel reinforced with channel or angle irons.

   b. Butt sections flush, end to-end against similar section without bolts, nuts, or cover plates causing interference.

   c. Removable top cover plates.

   d. Removable plates on end panels for future bus extension.

5. Section Mounting: Removable formed-steel channel sills and lifting angles.

6. Horizontal Wiring Compartments/Wireways: Accessible from front, full width, top and bottom.

7. Vertical Wiring Compartment: Full height, isolated from unit starters with removable hinged and latched cover, in each vertical section, minimum 100 mm wide, complete with cable tie clamps.

8. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, VFD/filter, or other unit capable of being wired from front without unit removal.

9. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.

10. Door Interlocking: Interlock starter and feeder doors mechanically so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access at any time.

11. External disconnect handles, padlockable in OFF position.

C. Main Breakers:

1. Molded case breaker.

2. A visible window to confirm the circuit breaker main contact position (either opened or closed).

D. Key Interlock System:

1. Refer to Contract Drawings.

E. Feeder Breakers:

1. Molded case circuit breaker.

F. Bus:

1. Horizontal Power Bus:

   a. Three phase tin plated, copper, entire width of control centre, rated as indicated in the Contract Documents.

   b. Construct to allow future extension of additional sections.

   c. Pressure type solderless lugs for each incoming line cable.

   d. Isolated from top horizontal wireway.

2. Vertical Power Bus:

   a. Three phase tin plated copper, full height of section, rated 600 amperes.

   b. Sandwich type bus insulation providing dead front construction with starter units removed except for bus stab openings.

   c. Insulated and isolated barrier complete with shutters.

3. Neutral Bus: None.

4. Ground Bus:

   a. Copper, tin plated, 33 percent minimum of phase bus ampacity, entire width of control centre.

5. Bus Bracing: As indicated on Drawings.

G. Motor Controller Unit:

1. Install control transformers for each starter, single phase, dry type, secondary 120V or 24V AC, rating as indicated plus 20% spare capacity, secondary fuse kit (terminal block type chips) and fuse, size as indicated, close voltage regulations as required by magnet coils and solenoid valves.

2. Provide indicated individual components and control devices including not limited to pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time.

3. Construction:

   a. Plug-in combination type with stab connections for starters NEMA ICS, Size 4 and smaller.

   b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 5 and larger.

c. Readily interchangeable with starters of similar size.

d. Pull-apart unit control wiring terminal boards on draw out units on all units.

4. Starters:

a. NEMA ICS 2, standard rating, none smaller than NEMA, Size 1.

b. Rating: Hp rated at 600 volts, CSA labeled for indicated fault amperes with overload protection.

c. Three-phase.

d. Disconnect Type: Motor circuit protector.

e. Combination Full Voltage, Magnetic Starter:

1. Control As shown on the Drawings.

2. Pilot Lights: Red (ON), Green (OFF), Amber (FAULT).

5. Disconnecting Device:

a. As indicated in the Contract Documents.

b. Padlockable in OPEN position.

6. Circuit Breaker:

a. Moulded case with Manufacturer's recommended trip setting for maximum motor protection.

b. Thermal magnetic trip or magnetic trip only as shown on the Drawings.

c. Tripping indicated by operating-handle position.

d. Interrupting capacity required for connection to system with short circuit capacity indicated.

7. Capacitor Connection: Terminals to allow easy connection of power factor correction capacitors on source side of starter overload relays on starters where capacitor connection is shown on the Drawings.

H. Control Unit:

1. Disconnecting Device: Capable of de energizing external source control circuits in unit.

2. Control Devices:

a. Operator's Devices: Heavy duty, industrial, oil tight, functions as indicated in the Contract Documents (pushbuttons, selector switches and indicating lights), rated 120 V AC and prewired to starter terminal blocks.

b. Indicating Lights: Integral transformer type, push-to-test, with long life incandescent or clustered LED lamps replaceable from front without disconnecting power supply.

c. Future Field Installation: Knockouts where no control devices are indicated in the Contract Documents.

d. Device Colours: As indicated in the Contract Documents.

e. General Purpose Relays: Heavy duty, industrial, enclosed, EEMAC rated, electrically held, 120 V coil, 60 Hz, 10 amp, 120 V AC convertible contacts, Type P by Allen-Bradley Canada Ltd., Type X by Square D Canada, Type AR by Cutler-Hammer.

f. Timing Relays: ON delay, OFF delay or Interval type, enclosed, 120 V AC coil, 10A, 120 V AC, convertible contacts, knob adjustable timing range as indicated, Type PT or NT by Allen-Bradley Canada Ltd., Type X by Square D Canada, or Type ARPT by Cutler-Hammer.

g. Elapsed Time Meters: Non-reset type, calibrated in tenths of an hour, range to 99999.9 hours where indicated in the Contract Documents.

3. Control Wiring:

a. Minimum wire size, 14 AWG copper.

b. Permanent sleeve type markers with wire numbers applied to each end of wires.

c. Terminate wires using insulated locking fork or ring type crimp terminals.

d. Terminate current transformer leads on shorting type terminal blocks.

I. Digital Power Meter:

1. ION 7650 by power Measurement (Schneider Electric).

2. Allen Bradley PM 3000 M4, M5, M6 or M8.

J. Surge Protection Device:

1. Rating as per Contract Drawings, as per Manufacturer recommendations.

2. Supplemental circuitry to remotely monitor the status of all protection modes.

3. Shall meet requirements in Specification 16440.01 – Transient Voltage Surge Supression.

K. Pushbuttons, Indicating Lights, and Selector Switches: As specified in Section 16050 – Basic Electrical Materials and Methods.

L. Nameplates:

1. MCC Identification: Lamacoid, with white letters on black background, centrally mounted on both sides.

2. Provide for each motor control centre and each unit.

3. Warning Sign: Lamacoid with 13 mm white letters on red background, on front of main supply compartments to identify power sources.

4. Warning Labels: Lamacoid with 3 mm white letters on red background, on front of compartments where multiple power sources are or maybe present.

5. Compartment Identification: Lamacoid, with white letters on black background, identifying load by equipment number and function.

6. Provide for each motor control centre and each unit.

7. Engrave with inscription shown on Single-Line Diagram.

8. Provide blank nameplates on spaces for future units.

9. Attach with stainless steel panhead screws on face of control centre. Grind back of screws flush so no sharp edges protrude.

M. Automatic Transfer Switch:

1. Refer to Section 16627.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with Manufacturer's instructions and recommendations.

B. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

E. Grout mounting channels into floor or mounting pads.

F. Check factory-made connections for mechanical security, electrical continuity and phasing.

G. Retighten current-carrying bolted connections and enclosure support framing and panels to Manufacturer's recommendations.

H. Provide grounding connections between equipment ground buses and building grounding system.

I. Remove foreign material, including dust before energizing equipment.

J. Connect power, control and grounding wiring.

3.2 CIRCUIT BREAKERS

A. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.

B. Adjust to approximately 11 times the motor rated current.

C. Determine the motor rated current from motor nameplate following installation.

3.3 OVERLOAD RELAY

A. Adjust to suit the actual nameplate full-load current of the motor.

B. Ensure correct protection devices installed as per coordination study, including current transformer rating, fuse ratings, and protective device setting.

3.4 MOTOR DATA

A. Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:

1. Motor served by tag number and equipment name.
2. Nameplate horsepower.
3. Motor code letter.
4. Full load amperes.
5. Service factor.

3.5 FIELD QUALITY CONTROL

A. System Harmonic Study:

1. Use a BMI Model 355 or Dranetz Model No. 626PA or equivalent harmonic distortion monitor and Series 626 disturbance analyzer or equivalent instrument to document results.
2. Test to be conducted in accordance with IEEE 519 general practices with plant load connected to normal utility source. Measure the following to show parameters within the specified limits of IEEE 519:
    a. Total and individual current harmonic distortion (up to and including 35^{th} harmonic) at the 600-volt PCC on the MCC bus.
    b. VFD's running at full load and half load.
    c. Half of the specified VFDs running at full load and half load.
    d. Provide harmonic mitigation if required to meet IEEE 519.
    e. Provide harmonic study report.

C. Provide start up test report.

D. In accordance with Section 16080 – Electrical Testing.

E. Prior to energization, provide confirmation, in writing, that solid state devices have been activated, programmed, calibrated, and set.

F. Perform tests in accordance with Section 16010 – Electrical General Requirements.

PART 4. DATA SHEETS

4.1 MCC-INTAKE

A. Sheet No. 1

EQUIPMENT NUMBER(S): MCC-Intake		**SERVICE DESCRIPTION: Primary Clarifier**	
DESCRIPTION	**REQ'D**	**DESCRIPTION**	**REQ'D**
Single Line Diagram Drawing #	**E-006**	STRUCTURE	
MCC Status [**N**ew or **A**ddition to Existing]	**New**	EEMAC Enclosure Type [**1, 1A, 3R** or **12**]	**1A, gasketed**
		Arrangement [**F**ront Access Only or **B**ack-to-Back]	**F**
AMBIENT CONDITIONS		Exterior Finish	ASA 61 Grey
Location [**I**ndoor or **O**utdoor]	**INDOOR**	Interior Finish	Matte White
Ambient Design Temperature	**40°C**		
Altitude above sea level	**m**	INCOMING LINE TERMINATIONS	
Environment [**C**lean, **W**et, **D**usty, **H**umid, **C**orrosive]	**CLEAN**	Entry [**T**op, **B**ottom or **T**op and **B**ottom]	**T/B**
		Main Disconnecting Device Type [**C**ircuit Breaker, **D**isconnect Switch or **N**one]	C
POWER SUPPLY		Service Entrance Type [**Y**es or **N**o]	**Y**
Nominal Voltage	**600 V**		
No. of Phases	**3**	MAIN CIRCUIT BREAKER	
Frequency	**60 Hz**	Type [**M**oulded Case, **I**nsulated Case or **A**ir]	**M**
Wire System [**3** or **4**]	**3**	Fault Closure Withstand Rating	See Drawing
Available Symmetrical Short Circuit Current	**35KAIC**	Frame Size	600A
System Grounding [**S**olid, **L**ow-Resist., **H**igh Resist. or **U**ngrounded]	**S**	Number of Poles [**3** or **4**]	3
EQUIPMENT NUMBER(S): MCC-Intake		**SERVICE DESCRIPTION: Intake Pump Station**	
DESCRIPTION	**REQ'D**	**DESCRIPTION**	**REQ'D**
		Operation [**A**utomatic or **N**on-Automatic]	A
		Draw Out [**Y**es or **N**o]	N
BUSES			
Material [**C**opper or **A**luminium]	**Copper**		
Plating [**T**in or **S**ilver]	**Tin**		
Fully Insulated [**Y**es or **N**o]	**No**		
Fault Withstand Rating	**35KAIC**		
Main Bus Rating	**600A**		
Neutral Fully Rated [**Y**es or **N**o]	**N**		
Minimum Vertical Bus Rating [**300** or **600**A]	**600 A**	LOAD SIDE CONDUCTORS	
		Entry [**T**op, **B**ottom or **T**op and **B**ottom]	T/B

B. Sheet No. 2

EQUIPMENT NUMBER(S): MCC-Intake		**SERVICE DESCRIPTION:**	
DESCRIPTION	**REQ'D**	**DESCRIPTION**	**REQ'D**
FEEDER UNITS			
Type [**C**ircuit Breaker or **F**used Switch]	**C**		
Minimum Frame Size	**300 A**		
Fault Interrupting Capacity	**25KAIC**		
Plug Out to 400 A [**Y**es or **N**o]	**Yes**		
Dual Mount [**Y**es or **N**o]	**Yes**		
COMBINATION STARTER UNITS			
Type [**C**ircuit Breaker or **F**used Switch]	**Circuit Breaker**		
Fault Interrupting Capacity	**25KAIC**		
Plug Out to EEMAC Size 5 [**Y**es or **N**o]	**Yes**		
Overload Type [**S**tandard or **A**mbient Compensated]	**Solid State**		
Overload Alarm Contacts [**Y**es or **N**o]	**Yes**		
Minimum Contactor Size	**EEMAC 1**		
EEMAC WIRING			
Class [**I** or **II**]	**I**		
Type [**A, B** or **C**]	**B**		
CONTROL CIRCUIT			
Individual Transformer [**Y**es or **N**o]	**Yes**	MISCELLANEOUS	
Control Voltage	**120 V**	Space Heaters with Thermostat [**Y**es or **N**o]	**No**
Primary Fuses [**Y**es or **N**o]	**Yes**	Drip Hood [**Y**es or **N**o]	**No**
Secondary Fuses [**Y**es or **N**o]	**Yes**	Channel Sills [**Y**es or **N**o]	**Yes**
Minimum Extra Transformer Capacity	**50 VA**	Bottom Gland Plates [**Y**es or **N**o]	**No**
		Vermin Proof [**Y**es or **N**o]	**Yes**
		Witness Tests [**Y**es or **N**o]	**No**
REMARKS:			

END OF SECTION

PART 1. GENERAL

1.1 SUMMARY

A. The Specifications in this Section describe the electrical and mechanical requirements for a protection system provided by high-energy transient voltage surge suppressors. The specified system shall provide effective, high-energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category A, B and C environments (as tested by ANSI/IEEE C62).

B. Related Specification: Section 16440 – Low Voltage Motor Control Centre.

1.2 STANDARDS

A. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

1. Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.11, C62.41, C62.45).
2. America National Standards Institute.
3. Federal Information Processing Standards Publication 94 (FIPS PUB 94).
4. National Electrical Manufacturer Association.
5. National Fire Protection Association (NFPA 70, 75 and 780).
6. MIL Standard 220A Method of Insertion Loss Measurement.
7. National Electric Code.
8. Underwriters Laboratories UL 1283/UL 60384-14 and UL 1449 (most recent edition).
9. Canadian Standards (cUL or cETL.)
10. Canadian Standards Association:
    a. Canadian Electrical Code C22.1 (Part 1) and C22.2 (Part 2)
11. RoHS compliant.

1.3 ENVIRONMENTAL REQUIREMENTS

A. The operating temperature range shall be -40° to 70° C (-40° to 160° F).

B. The unit shall be capable of operation up to 13,000 feet above sea level.

C. No appreciable magnetic fields shall be generated.

1.4 SUBMITTALS

A. Product Data: Provide catalog sheets showing voltage, physical size, IEEE let through voltage for each waveform listed, UL1449 latest revision, latest edition, suppressed voltage ratings, dimensions showing construction, lifting and support points, enclosure details, per mode and per phase peak surge current, modes of discrete suppression circuitry, warranty period and replacement terms, conductor size, conductor type and lead length.

B. Submit product data for all components and accessories.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product. Indicate maximum size of circuit breaker or fuse to be connected for each unit.

D. List and detail all protection systems such as fuses, disconnecting means and protective features.

E. Provide verification that the TVSS device complies with the required UL1449 latest edition, latest revision, and CSA Approvals.

F. Provide actual let through voltage test data in the form of oscillograph results for the ANSI/IEEE C62.41 Category B/C (combination wave) and A1 (ringwave) tested in accordance with ANSI/IEEE C62.45.

G. Provide spectrum analysis of each unit based on MIL-STD-220A test procedures between 10 kHz and 100 kHz verifying the devices noise attenuation equals or exceeds 40 dB at 100 kHz.

H. For retrofit mounting applications, provide Electrical/Mechanical Drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.

I. Provide test report from a recognized independent testing laboratory verifying the suppressor components can survive published surge current rating on a per mode basis using the IEEE C 62.41, 8 x 20 microsecond current wave. Test data must be on a complete SPD with internal fusing in place. Test data on an individual module is not acceptable.

1.5 QUALITY ASSURANCE AND WARRANTY

A. The following warranty requirements shall be in addition to and run concurrent with other warranty requirements provided in project Contract Documents.

B. Minimum Requirements:

1. Thirty (30) Years Unlimited Replacement Warranty on all parallel-wired Surge Protective Devices (SPD). Additionally, the warranty shall state that during the applicable warranty period any SPD which fails due to any transient surge activity, including lightning, shall be repaired or replaced by the Manufacturer without charge.

2. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

3. Warranty shall be for purchaser, building owner or end user and shall not be dependent on specific purchase entity for unit.

4. In the event the SPD is destroyed, there shall be full replacement of damaged or failed suppressor. Pro-rating is not allowed.

5. No exclusions from transient surge events (i.e., lightning strike, arcing fault on system, facility or utility transients). Gross negligence is excluded (i.e., removing system neutral to ground bond, Hi-Pot testing with SPDs on-line, etc.).

C. Since "Acts of Nature" or similar statements typically include the threat of lightning to which the SPDs shall be exposed, any such clause limiting warranty responsibility in the general conditions of this Specification shall not apply to this particular Section. That is, the warranty must specifically provide for unlimited free replacements of the SPD in the event of failure caused by the effects of lightning and all other electrical anomalies. The warranty shall cover the entire device, not just various components, such as modules only.

D. Provide electrically operated equipment specified in this Section that is listed and labeled. As defined in the National Electrical Code, Article 100, Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

E. Comply with NFPA 70 and former NEMA LS1.

1.6 MANUFACTURER QUALIFICATIONS

A. The SPD's shall be manufactured in the USA or Canada by a Manufacturer that has been regularly engaged in the design, manufacturing and testing of SPD's of the types and ratings required for a period of not less than five years. Manufacturers requesting product approval must meet or exceed the written Specification contained herein.

Manufacturers requesting approval must receive written verification of product acceptance by the Specifying Engineer 10 days prior to the bid date.

PART 2. PRODUCTS

2.1 PERFORMANCE

A. General:

1. The SPD shall be listed by ETL, UL\ULC, or other nationally recognized test laboratory to UL's 1283 and UL's 1449 Standards (latest edition, latest revision), and not merely the components or modules. All SPD's shall be Type 1 for use in Type 1 and Type 2 locations. All SPD units shall to RoHS compliant.

2. The SPD shall protect all modes L-G, L-N, L-L, and N-G, for WYE systems have discrete suppression circuitry in L-G, L-N and N-G, and have bidirectional, positive and negative impulse protection. Line-to-neutral-to-ground protection is not acceptable where line-to-ground is specified, and accordingly reduced mode units with suppression circuitry built into only 4 modes are not acceptable. For delta systems, the unit shall have discrete suppression circuitry in L-G and L-L.

3. The maximum continuous operating voltage (MCOV) of all components shall not be less than 125% for a 120V system and 120% for 220 and 240V systems, and 115% for 277 and 480V systems.

4. All SPDs shall be equipped with a comprehensive monitoring system which shall include a visual LCD panel display providing information on unit status and phase loss/protection loss.

5. All SPDs shall be Total Protection Solutions. No unit will be accepted as an "approved equal" unless it meets the warranty, strength, safety features, IEEE let-through levels, modes of discrete suppression circuitry, fusing, independent third party per mode surge testing, and all other requirements of this Specification.

6. If a disconnect switch is specified, the disconnect switch and the SPD as a system shall be capable of interrupting up to a 200kA symmetrical fault current with 600 VAC applied.

7. Each design configuration shall have the maximum single pulse surge current capacity per mode verified through testing at an independent, nationally recognized test laboratory not affiliated with the Manufacturer. To be considered for approval, the Manufacturer must submit a test report on a unit which was tested with internal over current fusing in place. The test shall include a 1.2 x 50 µsec 6000V open circuit voltage waveform and an 8 x 20 µsec 500A short circuit current waveform to benchmark the unit's suppression voltage, followed by a single pulse surge of

maximum rated surge current magnitude with an approximated 8 x 20 µsec waveform. To complete the test, another identical surge shall be applied to verify the unit's survival. Compliance is achieved if the suppression voltage found from the two impulses do not vary by more than +10%. Test data on an individual module is not acceptable.

8. SPD shall be separate from panelboard. Integral SPD shall not be acceptable.

B. Service Entrance Protection – MCC-1:

1. The SPD for this location shall be as indicated on Project Drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD's shall be certified to UL1283 and UL 1449 Fourth Ed. Type 1 for use in Type 1 or Type 2 locations. All SPD units shall be RoHS compliant.

2. Service entrance panels shall be protected by a Total Protection Solutions) panel mounted SPD, model TK-ST160-600NN-L for 600 Delta (3W+G) volt System.

3. The Manufacturer shall provide written Specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 2002, categories B/C and C-High bi-wave, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, and UL suppressed voltage ratings, all of which shall be no higher than:

ANSI/IEEE C62.41-2002 Measured Limiting Voltage				
B/C Impulse (6kV, 3kA)				
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
600 delta (600NN)	2022V	2217V		
C-High Impulse (20kV, 10kA)				
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
600 delta (600NN)	2420V	2410V		
UL Voltage Protection Ratings				
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
600 delta (600NN)	2500V	2500V		

4. The unit shall have a peak surge current of no less than 160kA/phase, 80kA/mode, 8 x 20 us waveform, single impulse, independently verified.

5. Internal Fusing – Overcurrent Protection:

    a. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.

    b. Fusing shall be present in every mode, including Neutral-to-Ground.

    c. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

    d. The SPD shall be marked with a Short Circuit Current Rating (SCCR) and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code Article 285.

6. The SPD shall come standard with not less than a 30 Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

7. The suppressor shall include Form C dry contacts (N.O. or N.C.) for remote monitoring capability and shall have at minimum a NEMA 4 steel enclosure.

8. The SPD shall have an internal audible alarm with mute on front cover.

C. Panel “A”:

1. SPD(s) for this location shall be as indicated on Project Drawings. SPD shall be separate from panelboard. Integral SPD shall not be acceptable. SPD’s shall be certified to UL 60384-14 (formerly UL1283), and UL1449 Fourth Ed. Type 1 or 2 for use in Type 1 and Type 2 locations. All SPD units shall be RoHS compliant. Integral SPD shall not be acceptable.

2. Subpanel shall be protected by a Total Protection Solutions panel mounted SPD, model TK-ST080-3Y208-L-F for 120/208 (4W+G) volt panels.

3. The Manufacturer shall provide written Specifications showing let-through voltage of the unit with six inches of lead length (at the module or at the lug data is not acceptable as it does not represent true "as installed" performance) pursuant to ANSI/IEEE C62.41 and C62.45, 1991, Categories A1 & A3 Ring Wave, 180 degree phase angle, category B3 Ringwave, and UL suppressed voltage ratings, 90 degree phase angle, positive polarity, measurements in peak voltage from the zero reference, all dynamic tests except N-G, which shall be no higher than:

ANSI/IEEE C62.41-1991 Measured Limiting Voltage

A1 Ring Wave (2kV, 67A)	Tested at 180 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	40V	76V	46V	54V
B3/C1 Impulse Wave(6kV, 3kA)	Tested at 90 degree phase angle			
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	624V	636V	970V	624V
UL Voltage Protection Ratings				
Voltage (Voltage Code)	L-N	L-G	L-L	N-G
120/208 (3Y208)	700V	700V	1000V	700V

4. The unit shall have a peak surge current of no less than 80kA/phase, 40kA/mode, 8 X 20 us waveform, single impulse, verified by third party test reports.

5. Internal Fusing – Overcurrent Protection:

    a. Each Metal Oxide Varistor, or other primary suppression component, shall be individually fused for safety and performance to allow the SPD to withstand the full rated single pulse peak surge capacity per mode without the operation or failure of the fuses. Overcurrent fusing that limits the listed peak surge current of the SPD is not acceptable. Replaceable cartridge type per phase or per mode overcurrent fusing is not acceptable where there is more then one MOV per mode.

    b. Fusing shall be present in every mode, including Neutral-to-Ground.

    c. The fusing shall be capable of interrupting up to a 200kA symmetrical fault current with 600VAC applied.

    d. The SPD shall be marked with a Short Circuit Current Rating (SCCR) and shall not be installed at a point on the system where the available fault current is in excess of that rating per the National Electric Code Article 285.

6. The SPD shall be capable of attenuating internally generated ringing type transients and noise and shall have an enhanced transient filter supported by a Specification sheet which lists the IEEE A1 Ring Wave let-through levels no higher than those set forth above.

7. The suppressor shall include Form C Dry Contacts (N.O. or N.C.) for remote monitoring capability and shall have at minimum a NEMA 1 steel enclosure.

8. The SPD shall come standard with not less than a Thirty Year Warranty, and the warranty shall include unlimited free replacements of the unit if destroyed by lightning or other transients during the warranty period. Special or optional warranties in excess of the unit's standard warranty for purposes of this bid are not acceptable.

9. The SPD shall have an internal audible alarm with mute on front cover.

PART 3. EXECUTION

3.1 INSTALLATION

A. Install the SPDs with the conductors as short and straight as practically possible.

B. Follow the SPD Manufacturer's recommended installation practice as outlined in the Equipment Installation Manual. The Electrical Contractor shall ensure that all neutral conductors are bonded to the system ground at the service entrance or the serving isolation transformer prior to installation of the associated SPD.

C. Main service entrance SPDs shall be installed on 60 to 100 amp dedicated breakers, or, where indicated, shall be installed on a fused disconnect switch provided by Total Protection Solutions, or other Manufacturer, that meets or exceeds the fault current rating of the switchgear.

D. Distribution panel and motor control center units shall be installed on 60 amp dedicated circuit breakers, or, where indicated, shall be wired directly to the main lugs or feed through lugs, or wired directly to the bus bars.

E. Branch panel SPDs fed from step-down transformers or located downstream of distribution panels shall be installed on 30 amp dedicated circuit breakers.

F. The installing contractor shall comply with all applicable codes.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. The variable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of IEC, UL, CUL and NEMA.

2. IEEE 519 Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

3. National Electrical Manufacturer's Association (NEMA):

    a. MG-1, Motors and Generators.

1.2 SCOPE

A. This Section covers AC voltage source and Pulse Width Modulated (PWM) type adjustable frequency drives.

B. Line Reactor shall be supplied as part of VFD housing within the Section of the MCC.

C. Contractor is to conduct site investigation to ensure the Line reactor, VFD and harmonic filters are able to fit in the available space. Contractor is to coordinate with VFD Supplier for equipment installation, connection, testing and commissioning.

1.3 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Shop Drawings:

1. Variable frequency drive amp rating with motor HP; list any drive special features being supplied.

2. Maximum heat dissipation from enclosure.

3. Layout of VFD door showing any keypads, pushbuttons, switches, instruments, indicating lights, etc.

4. Schematic (elementary) Wiring Diagrams.

5. Interconnection Diagrams between controller, drive motor and all related components or controls external to system, including wire numbers and terminal board point identification.

6. One-Line Diagram, including component ratings.

7. Descriptive literature for all control devices such as relays, timers, etc.

8. Itemized bill of materials listing all system components.

9. List of configurable parameters c/w factory default settings, as-shipped settings, and blank spaces for field adjusted values.

10. Details of support(s) and anchorage provided to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.

C. Quality Control Submittals:

1. Special shipping, storage and protection, and handling instructions.

2. Manufacturer's printed installation instructions with Operation and Maintenance Manual.

3. VFD final inspection and no load test report.

4. Field reports from start-up/commissioning of VFD's

5. Suggested spare parts list to maintain equipment in service for a period of five (5) years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.

6. List special tools, materials, and supplies furnished with equipment for use prior to and during start-up and for future maintenance.

D. Operating and Maintenance Manuals:

1. Submit Operating and Maintenance Manuals in accordance with Section 01800.

PART 2. PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturer:

1. Toshiba (Toshont).
2. Allen Bradley.
3. Mitsubishi.

2.2 SERVICE CONDITIONS

A. Ambient Operating Temperature: 25 degrees Celsius (C).

B. Storage Temperature: -25 to 65 degrees Celsius (C)

C. Humidity: 0 to 95 percent relative (no condensing).

D. Frequency Stability: Plus, or minus 0.1 percent of maximum frequency.

2.3 VFD FEATURES

A. VFD Supplier is responsible for programming the VFD to achieve the functional requirements and operation described herein.

B. Products shall be based on the latest Pulse Width modulation Technology. Provide 12 pulse or better.

C. Real Time Clock.

D. VFD shall include a feature for uploading parameter settings to VFD memory and downloading from VFD to the same VFD or to another VFD.

E. Enclosure:

1. Rated same as MCC Section with operator controls installed on door, otherwise indicated on Contract Drawings.
2. Door interlocked disconnect switch.

3. Designed to prevent EMI emissions and also meet IEEE 519 Voltage Harmonics Standards.

4. Complete with VFD, relays, control transformer, input reactor.

F. Rating:

1. Input Voltage: Continuous operation at 600 V with a variation of 10%. Trip range to be between 380 V and 780 V.

2. Frequency: 60Hz with a variation of 48 to 63 Hz.

G. Ventilation:

1. If required, provide thermostatically controlled internal fans.

2. Alarm contacts to indicate fan failure or high internal temperature in the MCC Section.

3. Noise level of each unit not to exceed 80 dBA measured at 1 m distance in free field conditions.

4. Comply with FCC requirements for conducted EMI/RFI generated noise.

H. Provide enhanced Input surge and transient protection via MOVs and integral reactor for quiet motor operation due to continuously variable carrier frequency and to IEEE C62.41-1991 for location Cat. B2.

I. Fast acting input fuses.

J. Provide input line reactor.

K. Provide output dv/dt reflected wave control to ensure that spikes at motor do not exceed 1000 Volts.

L. Where indicated, provide Thermistor/RTD operated relays.

M. The following shall be mounted on the VFD front door:

1. 600V disconnect switch.

2. Enhanced door mounted operator display keypad to include as a minimum: Frequency, Voltage, Amps, Speed.

3. Local/Remote Selector Switch:

a. In local mode VFD is controlled from VFD Front door.

b. In remote mode, start/stop command is from PLC. Speed control will be 4-20 mA signal from PLC.

4. Speed indication keypad.
5. Speed adjust buttons.
6. Stop/start push button.
7. Running indication (Red), push to test type.
8. Fault indication (Amber), push to test type.
9. Others: Refer to Contract Drawings.

N. Refer to Contract Drawings for VFD control schematics and provide the following when applicable:

1. Incorporate controls for stopping the pump from thermistors/RTDs. Provide pilot light (push to test type) to indicate motor winding high temperature alarm.
2. Others: Refer to Contract Drawing for details.

O. Remote Monitoring and Control Interface:

1. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices. Isolated contact to indicate ''VFD Running" status.
2. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.
3. Communication:
    a. For remote monitoring, one of the following communication capabilities shall be provided:
        i. One (1) integral 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP protocols.
        ii. One (1) media protocol converter, interfacing the provided equipment to a 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP.

P. Provide Signals for Remote Monitoring as follows:

1. Isolated contact to indicate that VFD is controlled from remote location.
2. Isolated contact to indicate '' VFD Running '' status.
3. Isolated contact to indicate ''VFD Failure" alarm.

4. Isolated 4-20mA signal corresponding to speed.

5. Others: Refer to Contract Drawings for details.

Q. Accessories:

1. Equipment Identification Plate: Lamicoid with 1/4 inch engraved equipment tag number securely mounted in a readily visible location.

2. Lifting Lugs: Equipment weighing over 45 kgs.

3. Anchor Bolts: Support(s) and anchorage to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures. Type 316 Stainless Steel, sized by Equipment Manufacturer and supplied by the Contractor.

4. Spare power (three of each rating) and control fuses (ten of each rating)

2.4 HARMONIC FILTER

A. VFD Supplier is to provide harmonic filter. The harmonic filter may be installed the VFD enclosure within as part of the MCC or in a separate enclosure.

B. Voltage Distortion Factor: As defined by IEEE 519, 3% maximum at the input terminals. Harmonic analysis based on available symmetrical short circuit current of 20000 A at 600 V at input to VFD.

C. Input current harmonics: 20% maximum for any individual current harmonic and 30% maximum total current harmonics at rectifier input, with balanced and unbalanced line voltage, under any load condition.

D. Furnish isolating transformers or series reactors, harmonic filters, or other devices and circuits to prevent one drive from adversely affecting operation of other drives supplied from the same transformer or same bus.

E. Ensure that means are provided to prevent EMI and RFI, if any that are generated do not reflect back into the power distribution system.

F. Line notching: Notching area as defined by IEEE 519; 22800 V microseconds maximum with available short circuit of 35000 A at 600 V. Notch depth, 10% maximum of normal peak line-to-neutral voltage.

G. Enclosure:

1. Rated same as MCC Section unless otherwise indicated on Contract Drawings, suitable for floor-mounting or wall-mounting.

2. Pad lockable, with door interlocked disconnect switch.

2.5 FACTORY FINISHING

A. Enclosure:

1. Not Used. Refer to Section 16440 – Low Voltage Motor Control Centre.

2.6 SOURCE QUALITY CONTROL

A. Record final inspection information and no load test data, no load test to be performed with a small motor attached to the output of the drive, VFD units are to be powered up and verified to operate properly, report to be provided.

PART 3. EXECUTION

3.1 FIELD QUALITY CONTROL

A. Functional Test:

1. Conducted on each VFD by Factory Trained Service Technician.
2. Inspect controller for electrical supply termination connections, interconnections, grounding and proper installation.
3. Motor conduit box to be opened and cable terminations inspected.
4. Motor cables to be disconnected at VFD and motor meggered.
5. Record this data for commissioning report.

B. Performance Test:

1. Conducted on each VFD controller in combination with other equipment representatives and the direction of site personnel.
2. Power up and operate VFD to verify VFD programming parameters.
3. Determine proper rotation of motors, program and verify.
4. Under actual or approved simulated operating conditions ramp VFD frequency across the proper speed range recording data at set intervals.
5. Save VFD programming parameters and supply copy with report.

6. Record test data for commissioning report.

3.2 CERTIFICATE OF INSTALLATION

A. On satisfactory completion of installation, start-up, Commissioning, testing and training for each VFD, submit to the Consulting Engineer the VFD Supplier's certification of the correctness of installation for each VFD. Certification from the VFD Suppliers to state that the VFD is installed correctly, is in full operating condition, and is operating in accordance with its design rating. Submit the original certificates to the Consulting Engineer.

3.3 TRAINING

A. Submit Training Instructions in accordance with Section 01800.

END OF SECTION

PART 1. GENERAL

1.1 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronic Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits.
2. Canadian Standards Association CSA C22.1 No. 141 Unit Equipment for Emergency Lighting.
3. Certified Ballast Manufacturer (CBM).
4. Federal Communications Commission (FCC).
5. Illuminating Engineering Society of North America (IESNA).
6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. Underwriters Laboratories Inc. (ULC).
8. NFPA No. 101 Life Safety Code.

1.2 SUBMITTALS

A. Submit PDF copies of submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Shop Drawings:
    a. Interior Luminaires:
        1. Catalogue data sheets and pictures.
        2. Luminaire finish and metal gauge.
        3. Lens material, pattern, and thickness.
        4. Candle power distribution curves in two or more planes.
        5. Candle power chart 0 to 90 degrees.
        6. Lumen output chart.

7. Mounting details.

8. Submit Shop Drawings sealed and signed by a Professional Engineer licensed in the Province of Ontario and retained by the Contractor that the lighting support(s) and anchorage are designed to the requirements of post-disaster facility as per the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.

9. After installation a Professional Engineer licensed in the Province of Ontario and retained by the Contractor shall complete a site review and then submit a letter, sealed and signed, stating that the lighting support(s) and anchorage are designed and installed to the requirements of post-disaster facility as per the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.

b. Exterior Luminaires:

1. Catalogue data sheets and pictures.

2. Luminaire finish and metal gauge.

3. Lens material, pattern, and thickness.

4. IESNA Lighting Classification and Isolux Diagram.

5. Fastening details to wall or pole.

6. LED fixture type, location, and method of fastening.

7. For light poles, submit wind loading, complete dimensions, foundation details, anchoring details and finish.

c. Lamps:

1. Voltages.

2. Colours.

3. Approximate life (in hours).

4. Approximate initial lumens.

5. Lumen maintenance curve.

6. Lamp type and base.

d. Drivers:

1. Type.

2. Wiring Diagram.

3. Nominal watts and input watts.
4. Input voltage and power factor.
5. Starting current, line current, and restrike current values.
6. Sound rating.
7. Temperature rating.
8. Efficiency ratings.
9. Low temperature characteristics.

e. Photo Time Control:

1. Wiring Diagram.
2. Contact ratings.

f. Photocells:

1. Voltage, and power consumption.
2. Ampacity.
3. Contacts and time delay.
4. Operating levels.
5. Enclosure type and dimensions.
6. Temperature range.

g. Occupancy Sensors:

1. Type.
2. Switching capacity.
3. Coverage.
4. Time delay AUTO/OFF adjustment.

h. Emergency Lighting Equipment including battery unit, exit signs and remote heads.

C. Training Instructions, Operating and Maintenance Manuals:

1. Submit Training Instructions in accordance with Section 01800 – Clean-Up, Start-Up, Commissioning and Training.

2. Submit Operating and Maintenance Manuals in accordance with Section 01330 – Submittals.

1.3 QUALITY ASSURANCE

A. Pre-installation Meeting:

1. Occupancy Sensors: Arrange a pre-installation meeting with the Manufacturer's Factory Authorized Representative at the City's facility, to verify placement of sensors and installation criteria.

B. Extra Materials: Furnish, tag, and box for shipment and storage, the following spare parts:

Item	Quantity
Spare LED of each type	Two complete units for all LED types.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store in original cartons, in a dry and protected space.

PART 2. PRODUCTS

2.1 LUMINAIRES

A. See the Luminaire Schedule on the Drawings.

B. Wire Leads: Minimum 12 AWG.

C. Soffit Installations:

1. ULC Labeled: SUITABLE FOR DAMP LOCATIONS.

D. Exterior Installations:

1. ULC Labeled: SUITABLE FOR WET LOCATIONS.

2. When factory installed photocells are provided, entire assembly shall have ULC label.

E. Hazardous Classified Areas:

1. See the Luminaire Schedule shown on the Drawings.

2.2 LEDS

A. See the Luminaire Schedule shown on the Drawings.

PART 3. EXECUTION

3.1 LUMINAIRES

A. General:

1. Install in accordance with the Manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount. Support(s) and anchorage to meet requirements of the Manufacturer's recommendations and the Ontario Building Code Division B, Part 4, Article 4.1.8.17 for Post-Disaster Structures.
4. Install plumb and level.
5. Mounting heights shown on the Drawings for pendant mounted luminaires are measured from bottom of luminaire to finished floor or finished grade, whichever is applicable.
6. Mounting heights shown on the Drawings for wall mounted luminaires are measured from center of mounting plate to finished floor or finished grade, whichever is applicable.
7. Install each luminaire outlet box with galvanized stud.

B. Pendant Mounted:

1. Space single stem hangers on continuous row fluorescent luminaires nominally 1200 mm apart.
2. Provide twin stem hangers on single luminaires.

C. Pole Mounted:

1. Provide cast in place concrete base.

D. Swinging Type: Provide, at each support, safety cable capable of supporting four times the vertical load from structure to luminaire.

E. Finished Areas:

1. Install symmetrically with tile pattern.

2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.

3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.

4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 38 mm from ceiling surface or use fixtures suitable for mounting on low density ceilings.

5. Junction Boxes:

    a. Flush and Recessed Luminaires: Locate a minimum of 300 mm from luminaire.

    b. In concealed locations, install junction boxes to be accessible by removing luminaire.

6. Wiring and Conduit:

    a. Provide wiring of temperature rating required by luminaire.

    b. Provide flexible steel conduit.

7. Provide plaster frames when required by ceiling construction.

8. Independent Supports:

    a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.

    b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.

    c. Fasten chain or wire to each end of luminaire.

F. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 10 mm threaded steel hanger rods. Scissor type hangers not permitted. Hang independent of pipes and ducts.

2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

G. Building Exterior: Flush mounted back box and concealed conduit, unless otherwise indicated in the Contract Documents.

3.2 CLEANING

A. Remove labels and markings, except ULC or CSA listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from Manufacturer.

E. Replace defective lamps at time of Substantial Performance of the Work.

END OF SECTION

PART 1. GENERAL

1.1 INTENT

A. This document provides specification for Supplier to design, fabricate, deliver, and supervise installation, test and commission of the outdoor, weather protected, sound attenuated, skintight, 150 kW standby rated diesel generator with a sub-base tank. It also provides some details on installation requirements for general contractor to connect generator to the automatic transfer switch.

B. The performance of the generator set and all associated equipment necessary for the complete and full operation of the generator to provide stand-by power to the site must meet or exceed the requirements specified herein.

C. The generator shall conform to the latest versions of the following standards and codes in addition to those noted in Section 16010:

1. BS5514 (ISO 8528) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Set.
2. CSA-B139 Installation Code for Oil Burning Equipment.
3. CSA-C22.2 No. 100 Motors and Generators.
4. CSA-C282 Emergency Electrical Power Supply for Buildings.
5. DIN 6271 Reciprocating Internal Combustion Engine Driven Alternating Current.
6. Generator Set Performance Standard Reference Conditions, Declaration of Power, Fuel Consumption and Lube Oil Consumption.
7. NEMA/EEMAC Standard MG1 Motors and Generators.
8. NEMA/EEMAC Standard M1-6 Motors and Generators.
9. NEMA/EEMAC Standard MG2 Safety Standard for Motors and Generators.
10. B139ON-06 CSA Special Publication – Ontario Installation Code for Oil Burning Equipment.

1.2 SCOPE OF SUPPLY

A. The Equipment Supplier shall provide the following:

1. Design, fabricate, deliver, supervise and co-ordinate installation with General Contractor, test and commission the pre-wired diesel generator complete with control panel, day tank, battery charger, breakers, a ladder and all other accessories necessary for complete and full operation of the diesel generator inclusive of remote operational status indication to City SCADA system.

2. Supervision of equipment installation, start-up, testing and commissioning services as per this Specification.

3. Delivery of Shop Drawings, equipment operation and maintenance manuals, test reports and certifications as per this Specification.

4. Accessories, tools and spares in accordance with Ontario Ministry of Environments Standard Specifications No. 2.

1.3 CO-ORDINATION WITH GENERAL CONTRACTOR AND SITE MANAGEMENT

A. The Equipment Supplier is responsible to coordinate supply and delivery of the equipment with the General Contractor. The Equipment Supplier is to provide safe storage off-site of any equipment manufactured in advance of the General Contractor's requirements for delivery.

B. The General Contractor will provide a concrete base in accordance with Contract Drawings and the Equipment Supplier's certified Shop Drawing for new diesel generator.

C. The General Contractor will provide the initial fuel fill of the generator sufficient for 24 hour continuous operation and assist the Equipment Supplier in the co-ordination of all commissioning and testing of the generator.

1.4 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for the engine-generator set, enclosure, fuel tank and all accessories and installation details including anchoring location requirements as required. Shop Drawings are to conform to applicable requirements of Ministry of Environment.

B. Shop and Site Test Reports: Submit a minimum of three certified copies of engine-generator set factory and site test reports to the Consultant. Include a copy of each report in each copy of the Operating and Maintenance Instruction Manuals.

C. Letter of Installation Certification: Submit a letter from the Engine-Generator Set Supplier to certify that the Supplier has visited the site to examine the engine-generator set installation, to check all connections and all safeties and control, and that the set appears to be properly installed and ready for site testing and test in accordance with C282-00.

D. Maintenance: Submit completed list of recommended spare parts.

E. Table 1 Data Form: Refer to the TABLE 1 DATA FORM (2 pages) contained in the end of this Section. Submit a completed copy of the Table 1 Data Form with Shop Drawings.

1.5 EQUIPMENT SUPPLIER STANDARD WARRANTY

A. The complete system including all controls and auxiliaries shall be guaranteed for a period of two years from date of final on site testing and acceptance to be free of all defects in workmanship and material. The Equipment Supplier shall include, if necessary, a minimum warranty float time of six months from factory shipment to final testing and acceptance before the commencement of the two (2) year Standard Warranty.

B. During the final month before expiry of the warranty period, the Diesel Generator Supplier shall provide technical staff to conduct an in-depth check out of the system.

C. Carry out full maintenance procedures and replace any components which have failed or have become degraded during the warranty period.

D. Submit a detailed itemized report covering all maintenance carried out.

E. All repairs made under this warranty including final month maintenance check shall be included in the tender cost.

PART 2. PRODUCTS

2.1 GENERAL DESIGN

A. Provide one standby rated 150 kW standby rated Generator, 600 V, 3 phase.

B. Engine generator unit shall be completely prewired and piped so that only field connections to a master terminal strip for control, auxiliaries and alarms, and power connections to molded case line circuit breakers will be required.

C. Provide engine generator set with weather protected, sound attenuated, skin-tight enclosure with following characteristics:

1. The housing shall include louvers with outside hoods for intake and discharge openings with bird screen and enclose the complete unit and all related equipment (e.g., battery, battery charger, engine controls and control panel). Enclosure shall be mounted on top of the double wall sub base fuel tank. All components shall be wired and piped within the enclosure. Exhaust silencer shall be hospital grade. Level 2 sound attenuation shall be applied on the enclosure by the Manufacturer. The unit is to be suitable for use in -40 C to + 40 C ambient.

2. All auxiliary devices mounted on the engine generator unit shall be factory wired to two junction boxes. One junction box shall be for control wiring and second junction box shall be for 120 V power.

3. The housing shall be constructed of minimum 14 gauge rolled steel. Housing surfaces shall be prime painted with two coats of a rust resistant primer and finished with a gray or beige enamel paint. Provide paint samples at the time of the Shop Drawings.

4. The housing shall be vandal proof and padlocked.

5. Exhaust silencer shall be thermally insulated and expanded metal guards shall be provided around flexible exhaust connectors to protect against burning. Stainless steel flexible exhaust sections shall be provided. Exhaust outlet shall be terminated with a “shanty cap” designed so to prevent entrance of rain into exhaust outlet. All handles, sheet metal screws, bolts, nuts, hinges, etc. shall be stainless steel.

6. The sound level of the enclosed emergency generator (including the muffler and all associated ventilation and radiated noise) is not to exceed 75 dBA measured in any direction 7 metres away from the generator according to ANSI S1.13 and/or ANSI S12.18 as applicable, provided that the sound quality is not tonal in nature according to ISO 1996-2:2006 (E) – Annex D; the sound pressure level is not to exceed 70 dBA if the sound quality is tonal in nature. If the sound quality is unknown, or unable to be determined, it should be assumed that the sound quality is tonal.

D. Provide micro processor-based controller that will provide isolated contacts for following conditions.

1. Alarm condition.
2. Pre alarm condition.
3. Engine run condition.
4. Auto Mode selected.
5. Refer to Contractor Drawing for details.

E. Provide a prefabricated stairs and railings in order to access generator from ground level, and to facilitate routine maintenance on the generator equipment that are inaccessible from ground level. Platform, railing and stairs to be construction of FRP material.

2.2 ENGINE

A. The engine governor shall be electronic isochronous type with manual speed adjustment. Transient speed variation not to exceed 9.6 Hz no load to full load and on starting motors listed in Table 1. Speed recovery time better than 5 seconds from instant of load change to steady state condition.

B. The engine shall start and operate in accordance with CSA Standard C282.00 with output as per Table 1 Data Form, Item T1.2 of this Section.

2.3 ALTERNATOR

A. The generator unit shall be capable of operating with solid state reduced voltage starters and variable frequency drivers and harmonic filters. Alternator rating shall not be less than required to provide stable power to the total linear and non-linear load listed. Refer to Contract Drawing for quantities and rating of line reactors and harmonic filters.

B. The alternator shall have a Permanent Magnet Generator exciter to achieve 300% short circuit for a minimum of 10 seconds.

C. The alternator shall comply with the requirements of NEMA/EEMAC Standard MG1 Motors and Generators. The alternator shall be rated for a temperature rise of 130^{o}C for Class ‘F’ insulation and for standby duty. Motor starting capability shall be suitable for motors described in table 1 with maximum voltage drop of 25 %.

2.4 CIRCUIT BREAKER

A. Provide a generator mounted circuit breaker, molded case, 225 amp trip, 3 pole, NEMA 1/IP22. Breaker shall utilize a LSIGA solid state trip unit. The breaker shall be UL/CSA Listed and connected to engine/generator safety shutdowns. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on Drawing, shall be supplied on the load side of breaker.

B. Provide a duplicate breaker for load testing. Provide the required terminals or connection devices for connecting a temporary load bank.

2.5 ACCESSORIES

A. The minimum battery rating shall include cold cranking amps at -18°C of at least 1050. The battery is to come complete with a suitable battery cover to prevent damage from material falling on it and shorting the terminals. Battery shall be equipped with battery warmer.

B. Drip pan to extend the full length of the support rails.

C. Gauges shall have intermediate markings to denote values within the range of the instrument within 10°C for coolant/oil, 50°C for exhaust or 50 kPa for pressure.

D. Where the load requires in excess of four spring isolators, provide supporting calculations to show how the load is shared to avoid overloading of individual isolators.

2.6 PERFORMANCE

A. Only equipment reviewed by the Engineer shall be installed. The final review shall be based on performance tests after installation.

2.7 EQUIPMENT TO CONFORM

A. The dimensions of all equipment supplied shall be clearly marked on the Shop Drawings submitted and shall be in metric units. Equipment shall not be installed that differs from the information shown on the Shop Drawings.

2.8 WIRING

A. Connect neutral of generator to neutral of the Automatic Transfer Switch resulting in a solid neutral system.

2.9 EXHAUST SYSTEM

A. Heavy duty, hospital grade, vertically mounted, exhaust silencer with condensate drain, plug and flanged couplings. Heavy duty flexible exhaust pipe with flanged couplings for bottom inlet and end outlet.

B. Fittings and accessories as required. Provide removable jacket type insulation on manifold.

C. Expansion Joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

D. The exhaust stacks that discharge contaminants, other than noise, from the system into the air shall be oriented vertically and shall be free of any impediments that would prevent the flow of the emissions.

2.10 EXHAUST EMISSIONS

A. Emissions: Conform to the EPA Tier 3 Emission Standards.

2.11 COOLING SYSTEM

A. The generator set shall be equipped with a rail-mounted, engine-driven radiator with blower fan and all accessories. The cooling system shall be sized to operate at full load conditions and 110 F* ambient air entering the room or enclosure (If an enclosure is specified). The Generator Set Supplier is responsible for providing a properly sized cooling system based on the enclosure static pressure restriction.

2.12 FUEL SYSTEM

A. Fuel System

1. The fuel system shall be integral with the engine. In addition to the standard fuel filters provided by the Engine Manufacturer, there shall also be installed a primary fuel filter/water separator in the fuel inlet line to the engine. All fuel piping shall be black iron or flexible fuel hose rated for this service. No galvanized piping will be permitted. Flexible fuel lines shall be minimally rated for 300 degrees F and 100 psi.

B. Fuel Sub Base Tank

1. Provide a double wall sub-base tank constructed to meet all local codes and requirements. The sub-base fuel tank shall be ULC listed and labelled. The fuel tank shall be a double-walled steel construction and include the following features:

    a. Sized to provide 24-hour run-time at 100% of generator rating.

b. Emergency tank and basin vents.

c. Mechanical level gauge.

d. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the Engine Manufacturer and in compliance to UL2200 and NFPA 37 requirements.

e. Leak detection switch, wired to the generator set control for local and remote alarm indication. Provide isolated contacts for remote alarm.

f. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level. For each condition, provide isolated contacts for remote alarm.

g. Fuel level sensing device to send analogue signal to City SCADA for fuel level continuous monitoring.

h. Basin drain.

i. Integral lifting provision.

j. Fuel tank shall be complete with:

   i. Fuel fill vent and emergency vents terminated outside the enclosure.

   ii. Fuel level gauge.

2.13 PAINTING

A. The equipment shall be supplied finish painted as per Manufacturer's Standard. The Manufacturer shall supply with the diesel generator set one 5 litre container of the original finish paint for touching up purposes.

2.14 WARNING SIGNS

A. Provide signs:

1. High Noise Level: Use Hearing Protection.

2. Warning: Auto Start:

   a. No Smoking.

   b. Flammable Liquid Storage Area.

B. Minimum dimensions 450 mm by 760 mm and shall be black embossed letters on a yellow background.

2.15 SUPPLIERS

A. The following listed Suppliers will be acceptable as reviewed equivalents for supplying, delivering, supervising the installation and testing of the diesel generator and accessories provided the conditions specified in this Section are met:

1. Cummins Ontario Limited.
2. Toromont/Cat Limited.
3. Total Power.

B. Other Suppliers must be pre-qualified by the Engineer.

PART 3. EXECUTION

3.1 INSPECTION IN FACTORY

A. The Engineer may inspect the manufacturing, assembling and testing facilities at a Supplier's factory, to satisfy him/herself the capability and facilities of the Supplier to Manufacture and test the required equipment. The Engineer may notify the Supplier at any time of unsatisfactory materials, workmanship or processes.

B. The Supplier shall provide every reasonable facility, access and co-operation to assist the Engineer in carrying out inspection or testing at the factory or plant.

C. No inspection or testing carried out by the Engineer shall relieve the Supplier of his responsibility for supplying equipment in accordance with the specifications and good engineering practice.

3.2 FACTORY TESTING

A. The Supplier is to give the purchaser written notice (with copies to the Engineer) two (2) weeks in advance of the date when the equipment will be ready for such testing. Equipment is not to be delivered to the site until such testing has been completed satisfactorily as specified.

B. Load testing at the factory will be performed at 1.0 power factor with load banks as required to provide 100% load. Perform four hours full load test (with generator set mounted in enclosure) followed by safety shutdown items and transient response for voltage and frequency.

C. The Supplier shall furnish copies of the required certified test reports, showing that the equipment complies with the specification, to the purchaser and the Engineer, before the equipment is delivered to the site.

3.3 INSTALLATION OF DIESEL GENERATOR

A. The General Contractor shall install the diesel generator equipment in accordance with Contract Drawings, Equipment Supplier certified Shop Drawings and installation instructions.

3.4 COMMISSIONING AND CERTIFICATION

A. The Equipment Supplier will provide a qualified technical representative to start-up and commission the generator arrange for the Engineer and Owner's Representatives to be present at the time of commissioning.

B. Site test will be repeat of the factory load test with exception that transient response test will not be required, temporary load bank with 50 feet of cable will be supplied by the Generator Supplier. Fuel shall be supplied by the general contractor.

C. Provide a Certificate of Correct Installation. Submit the certificate to the General Contractor and the Engineer.

3.5 SYSTEM ACCEPTANCE TESTING (SAT)

A. The Equipment Supplier will demonstrate for contract final acceptance that all the equipment is installed properly operational and perform full load connected tests in accordance with CSA 282 and submit a written report of the results.

PART 4. TABLES

4.1 TABLE 1 DATA FORM

A. The Equipment Supplier is to fully complete Table 1 Data Form appended at the end of this Section fully and submit with Tender response.

4.2 T1.1 LOAD REQUIREMENTS (IN-RUSH AND CONTINUOUS)

A. The generating set will supply all loads continuously, following the sequence listed below:

LOAD STEP	PUMP NAME	HP	DELAY	NOTE
Step 1	MISC BLDG SERVICES	20 kW	No	
Step 2	PUMP 1	44	Yes	VFD
Step 3	PUMP 2	44	Yes	VFD

TABLE 1 DATA FORM (Modified)

for DIESEL ENGINE GENERATOR SET

Project No. 60704677 Contract No. ISD24-169

Location & Jobsite Don Lita Lift Station

T2.1 BIDDER'S REFERENCE Bidder's Name, Address, Phone No., Quotation No. and Date:

T2.2 GENERATING SET

A. No. of sets _____ Country of assembly _____

B. Continuous rating of complete set _____ kW _____kVA

C. Dimensions L X W X H _____ mm Net weight approx. _____kg

D. Typical outline Drawing encl. #_____ Bulletins _____

T2.3 DIESEL ENGINE

A. Make, Model and Country of Mfr._____

B. Rated speed of _____ r/min per Table 1

C. Net continuous (prime power) required at shaft per Clause 3B _____kW

D. Continuous (prime power) available at shaft per engine curve _____kW

E. Overload (standby) available at shaft per engine curve _____kW

F. Brake Mean Effective Pressure _____kPa

G. Manufacturer's rating Curve No. enclosed _____

CYLINDERS AND COOLING

H. No. and arrangement _____ Compression ratio _____

I. Engine displacement _____ litres Two or Four stroke cycle _____

J. Method of engine cooling _____

RADIATOR

K. Air Flow _____L/s External Static Pressure of fan _____Pa

Duct connection size _____ X _____mm

FUEL GOVERNOR

L. Engine fuel consumption_____L/hr Supply line size_____mm Return size_____mm

M. Speed governor type, make and model _____

AIR AND EXHAUST

N. Aspiration - Natural or Turbo Ch. _____

O. Exhaust NOx emission rate at F.L. _____g/s

P. Heat radiated from engine to ambient _____kW

Q. Heat produced by generator _____kW

T2.4 GENERATOR

A. Make, Model and Country of Mfr. _____

B. Output _____ V _____ ph _____ Hz _____ kW _____kVA

C. Rating of the generator only, if greater than the generator set continuous rating _____kVA

D. One or two bearing _____ Efficiency at F.L. _____

E. Stator/Rotor – Insulation class _____/_____ F.L. temperature rise_____/_____C°

F. Voltage regulator make and model _____

T2.5 CONTROL PANEL

A. Make and Country of Assembly _____

B. Dimensions W x D x H_____mm

COMPONENT MAKE AND MODEL, ETC.

C. Breaker _____Meters _____

(Caution: A solid state trip breaker may not be suitable when used with VFD or RVSS loads).

D. CT _____ PT _____

E. Transfer Switch _____ Current Rating _____A

Transfer Switch withstand/closing rating _____ kA rms sym (when used with upstream C.B.)

T2.6 ANCILLARY EQUIPMENT

A. Accessories, tools, spares included per Part 16 _____

ITEM MAKE – MODEL ETC.

B. Battery _____ Voltage_____ CCA(-18°C)_____

C. Battery Charger _____ Vibration mounts _____

D. Silencer_____ Silencer grade_____ Silencer inlet size _____mm

T2.7 DEVIATION FROM SPECIFICATION

List all exceptions to the Specification. State "As below" OR "See separate letter (Sheet)" OR "No Deviations" whichever applies.

T2.8 ALTERNATIVES

State "See separate letter (sheet)" OR "None Proposed", whichever applies.

Name _____ Signature _____ Date _____

END OF SECTION

PART 1. GENERAL

1.1 WORK INCLUDED

A. Furnish all labour, materials, supervision, equipment and services specified, indicated or requested to install the automatic transfer switch specified herein and on the Drawings.

1.2 REFERENCES

A. CAN3-C13, Instrument Transformers.

B. CAN3-C17, Alternating-Current Electricity Metering.

C. ANSI/NEMA ICS 2, Industrial Control Devices, Controllers, and Assemblies.

D. ANSI/NEMA ICS 10-1993, AC Automatic Transfer Switches.

1.3 SYSTEM DESCRIPTION

A. General: The automatic transfer switch shall be capable of either open or closed transition operation as selected by door mounted control switch.

1. Closed Transition: The transfer switch shall automatically transfer the connected load to the generator supply in the event of a normal (utility) supply failure or when a “load test” mode is activated. The connected load shall automatically re-transfer back to the normal (utility) supply when normal (utility) power is restored or when a “load test” mode is terminated. All power transfers shall utilize closed transition (make-before-break) switching logic when both sources of power are available. During the closed transition transfer sequence, the two sources of power shall be momentarily interconnected for a maximum time of 100 ms. When only one source of power is available, the transfer control logic shall automatically revert to open transition (break-before-make) operation.

2. Open Transition: The transfer switch shall automatically transfer the connected load to the generator supply in the event of a normal (utility) supply failure or when a “load test” mode is activated. The connected load shall automatically re-transfer back to the utility supply when utility power is restored or when a “load test” mode is terminated. All power transfers shall utilize an open transition (break-before-make) switching logic. The power switching devices shall be electrically interlocked to prevent the utility and generator supplies from being interconnected.

B. Normal Power Fail and Restoration Mode – Closed Transition:

1. Monitor voltage on all phases of normal (utility) power supply.

2. Initiate cranking of standby generator unit on normal (utility) power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.

3. Transfer load from normal (utility) supply to standby generator unit when standby generator unit reaches rated frequency and voltage pre-set adjustable limits.

4. When normal (utility) power restored, confirmed by sensing of voltage on all phases above adjustable pre-set limit for adjustable time period, the normal (utility) return timer shall be initiated.

5. When the normal (utility) return delay timer expired, the transfer switch shall close the normal (utility) transfer power switching device once the generator and normal (utility) sources are in synchronism.

6. The two sources shall remain in parallel for a maximum of 100 milliseconds, then the generator transfer power switching device shall open to separate the two supplies.

7. The load shall immediately retransfer to the normal (utility) supply (if within acceptable limits) should the standby generator unit supply fail prior to expiry of the normal (utility) transfer delay.

8. Shut down standby generator unit after running unloaded to cool down using adjustable time delay relay.

C. On-Load Test Mode-Closed Transition:

1. Initiate cranking of standby generator unit on the request of on-load test for adjustable period of time.

2. Transfer load from normal (utility) supply to standby generator unit when standby generator unit reaches rated frequency and voltage pre-set adjustable limits, the closed transition transfer sequence shall be initiated.

3. The generator transfer power switching device shall automatically close once the generator and normal (utility) sources are in synchronism.

4. The two sources shall remain in parallel for a maximum of 100 milliseconds, and then the normal (utility) transfer power switching device shall open to separate the two supplies. The standby generator unit shall remain on load for the duration of the selected test mode.

5. When the test mode terminated, the transfer switch shall close the utility transfer power switching device once the generator and normal (utility) sources are in synchronism.

6. The two sources shall remain in parallel for a maximum of 100 milliseconds, and then the generator transfer power switching device shall open to separate the two supplies.

7. Shutdown standby generator unit after running unloaded to cool down using adjustable time delay relay.

D. Close Transition Operation Failure Condition:

1. A control logic circuit and timer shall continually monitor the closed transition operation time period. The timer shall be factory set for 100 milliseconds, which shall allow normal closed transition operation. The timer and alarm circuit shall not be activated under normal operation.

2. Should the closed transition operation time exceed 100 milliseconds, the following sequence of events shall occur.

3. If the transfer switch was transferring power from the generator source to the normal (utility) source and the generator switching device failed to open, an auxiliary trip relay shall trip open the normal (utility) power switching device to immediately separate the two power sources. The maximum time period both sources shall remain paralleled under this failure mode is 200 milliseconds.

4. If the transfer switch was transferring power from the normal (utility) source to the generator source and the normal (utility) switching device failed to open, an auxiliary trip relay shall trip open the generator power switching device to immediately separate the two power sources. The maximum time period both sources shall remain paralleled under this failure mode is 200 milliseconds.

5. The original source (i.e., prior to the transfer sequence) shall remain on load, separated from the other source. An alarm light and transfer controller shall indicate the failure condition which must be manually reset before the transfer switch shall re-attempt subsequent transfers.

6. Should a power switching device fail to close for any reason within a 5 minute time period, an alarm light and alarm relay contact shall be activated.

E. Normal Power Fail and Restoration Mode-Open Transition:

1. Monitor voltage on all phases of normal (utility) power supply.

2. Initiate cranking of standby generator unit on normal (utility) power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.

3. Open the normal (utility) power switching device and then close the generator transfer power switching device to transfer load from normal (utility) supply to standby generator unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.

4. When normal (utility) power restored, confirmed by sensing of voltage on all phases above adjustable pre-set limit for adjustable time period, the normal (utility) return timer shall be initiated.

5. When the normal (utility) return delay timer expired, the transfer switch shall open the generator power switching device, stop in the neutral position for the preset adjustable time delay, then close the normal (utility) transfer power switching device.

6. The load shall immediately retransfer to the normal (utility) supply (if within acceptable limits) should the standby generator unit supply fail prior to expiry of the normal (utility) transfer delay.

7. Shutdown standby generator unit after running unloaded to cool down using adjustable time delay relay.

F. On Load Test Mode – Open Transition:

1. An on-load test mode may be initiated in open transition which shall cause a simulated utility failure condition and transfer the load to the standby generator unit. The transfer sequence shall be the same as for a normal (utility) power failure except a neutral delay sequence shall occur when transferring from utility to the generator source.

G. Automatic Transfer Switch shall be Interlocked with MCC Main Breaker as follows:

1. In case of MCC main breaker shunt tripped by a remote lockable pushbutton station, the automatic load transfer equipment shall be inhibited from starting the standby generator unit and making a load transfer by interlocking with a normally-closed dry contact from the pushbutton station.

1.4 SHOP DRAWINGS

A. Submit Shop Drawings in accordance with Section 16010 – Electrical General Requirements.

B. Include:

1. Make, model and type.

2. Single-Line Diagram showing controls and relays.

3. Description of equipment operation including:

a. Normal power failure and restore in both closed transition and open transition.

b. On-load test in both closed transition and open transition.

c. Test control.

d. Manual control.

e. Automatic shutdown.

1.5 OPERATION AND MAINTENANCE DATA

A. Provide operation and maintenance data for automatic load transfer equipment for incorporation into manual specified in Section 16010 – Electrical General Requirements.

B. Detailed instructions to permit effective operation, maintenance and repair.

C. Technical Data:

1. Schematic Diagram of components, controls and relays.

2. Illustrated parts lists with parts catalogue numbers.

3. Certified copy of factory test results.

4. Copy of reviewed Shop Drawings.

1.6 SOURCE QUALITY CONTROL

A. Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested.

B. Tests:

1. Operate equipment both mechanically and electrically to ensure proper performance.

2. Check selector switch, in all modes of operation (Test, Auto, Manual, Engine Start) and record results.

3. Check voltage sensing and time delay relay settings and record all settings.

C. Check:

1. Automatic starting and transfer of load on failure of normal power and retransfer of load when normal power supply resumed in both closed and open transition.

2. Automatic shutdown.

3. In-phase monitor operation.

PART 2. PRODUCTS

2.1 GENERAL

A. ATS shall be supplied by Motor Control Centre Supplier.

B. Refer to Contract Drawing for details.

2.2 MATERIALS

A. Meters: To CAN3-C17.

B. Instrument Transformers: To CAN3-C13.

C. Contactors: To ANSI/NEMA ICS 2.

2.3 CONTACT TYPE TRANSFER SWITCH

A. Rated: 600 V, 60 Hz, 600 A, 3 phase, 4 wire, 4 poles, solid neutral.

1. Fault Withstand Rating: 50 kA symmetrical for 3 cycles.

2. Current Rating: 100% continuous load without de-rating.

B. Mechanism: One normal and one emergency three phase fully enclosed contacts, mounted on common base, designed for double throw action, electrically operated, mechanically held and interlocked, to be mounted within the MCC enclosure.

C. Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.

D. Auxiliary Contact: To initiate emergency generator start-up on failure of normal power.

2.4 CONTROLS

A. Microprocessor Controller:

1. The transfer switch controller shall be microprocessor based and shall contain voltage and frequency sensing, timing functions, and metering.

2. The transfer switch controller shall include a door-mounted operator LCD interface display and keypad as an integral part of the controller for viewing all available data and setting desired operational parameters.

3. Digital metering provided by the transfer switch controller shall have an accuracy of ±0.5% for all voltage and frequency readings.

B. Engine Control Selector Switch – Four Position "Test", "Auto", "Manual", "Engine Start":

1. Test Position: Normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.

2. Auto Position: Normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.

3. Manual Position: Transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start. If the transfer switch is on manual operation mode, a red light should indicate a warning on the control panel and auxiliary contact to be provided for transferring this signal to off site.

4. Engine Start Position: Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.

C. Indication Lights: LED indicating lights shall be provided, as minimum, one to indicate when the transfer switch connected to the normal source (green), one to indicate when the transfer switch connected to the emergency source (red), one to indicate when the normal power is accepted (green) and one to indicate when the emergency power is accepted.

D. Interlock: Accept a normally-closed dry contact from a remote pushbutton station so that the automatic load transfer equipment shall be inhibited from starting the standby generator and making a load transfer if the MCC main breaker is shunt tripped.

E. Voltage, Frequency and Phase Sensing:

1. Voltage and frequency on both the normal and emergency sources shall be continuously monitored.

2. Voltage sensing, one per phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage – overvoltage protection. Voltage sensing to initiate transfer of the load when normal power supply drops to 70% in any phase and pick up at 90% on all phases.

3. Repetitive accuracy of all settings shall be within ±0.5%.

4. Voltage and frequency settings shall be field adjustable in 1% increments.

5. Source differential sensing shall be provided for the closed transition operating mode.

6. Closed transition transfer shall be accomplished with no power interruption and without altering or actively controlling standby generator unit.

F. Time Delays:

1. Time delay, normal power to standby, adjustable, 5 seconds to 180 seconds.

2. Time delay on engine starting to override momentary power outages or dips, adjustable, 1 to 60 seconds delay.

3. Time delay to override momentary emergency source outage during initial loading of engine generator set, adjustable 1 to 60 seconds.

4. Time delay on retransfer from standby to normal power, two independently adjustable time delay modes, 20 seconds to 60 min, one-time delay for actual normal power failures and the other for the test mode. Time delay shall be automatically bypassed if the emergency source fails, and the normal source is available.

5. Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 20 seconds intervals to 60 min.

6. Time Delays for Closed Transition:

   a. 1 to 5-minute time delay on failure to synchronize normal and emergency sources prior to closed transition transfer.

   b. 0.1 to 0.99 second time delay on an extended parallel condition of both power sources during closed transition operation.

7. Time delay during transfer to stop transfer action in neutral position electrically to prevent fast transfer, adjustable, 5 seconds intervals to 180 seconds.

8. Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.

9. Solid state electronic in-phase monitor.

2.5 ACCESSORIES

A. Control Transformers: Dry type with 120 V secondary to isolate control circuits from:

1. Normal power supply.

2. Emergency power supply.

B. Relays: Continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:

C. Pilot lights to indicate switch position, green for normal, red for standby, mounted on front of MCC enclosure door.

D. Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms, including:

1. Power supply in 'Normal'.
2. Transfer switch in 'Auto'.
3. Power supply in 'Emergency'.
4. Automatic transfer switch in 'Fault'.

E. Include ASCO 5170 ethernet communication module.

2.6 EQUIPMENT IDENTIFICATION

A. Provide equipment identification in accordance with Section 16010 – Electrical General Requirements.

B. Control Panel:

1. For Selector Switch and Manual Switch: Size 4/5 nameplates.
2. For Meters, Indicating Lights, Minor Controls: Size 2/3 nameplates.

2.7 FABRICATION

A. Shop assembles transfer equipment including:

1. Mounting base and outdoor rated lockable enclosure with double door with operator controls installed on inner door.
2. Transfer switch and operating mechanism.
3. Control transformers and relays.
4. Accessories.

2.8 ACCEPTANCE MANUFACTURERS

A. The automatic transfer switch shall be supplied by the same supplier of the motor control centre. Type ASCO series 7000 Catalogue #J7ACTSA30600R5 or approved equal.

PART 3. EXECUTION

3.1 INSTALLATION

A. Locate, install and connect transfer equipment in MCC enclosure. Coordinate installation with ATS Manufacturer and as per their recommendations.

B. Check relays, solid state monitors and adjust as required.

C. Install and connect remote controls and alarms.

3.2 FIELD QUALITY CONTROL

A. Energize transfer equipment from normal power supply.

B. Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

C. Set selector switch in "Manual" position and check to ensure proper performance.

D. Set selector switch in "Engine Start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.

E. Set selector switch in "Auto" position and open normal power supply disconnect. Standby generator should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby generator should shutdown.

F. Repeat, at 1 hour intervals, 3 times, complete test with selector switch in each position, for each test, and for both closed and open transition.

G. Set selector switch in "Auto" position and open (shunt trip) normal power supply disconnect by remote pushbutton station. Automatic transfer switch should be inhibited from starting the standby generator and making load transfer.

END OF SECTION

PART 1. GENERAL

1.1 RELATED SECTIONS

A. Section 16010 – Electrical General Requirements.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronics Engineers Inc. (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
2. Canadian Standards Association (CSA).
3. Ontario Electrical Safety Code (OESC).

1.3 SUBMITTALS

A. Submit submittals in accordance with Section 01330 – Submittals.

B. Action Submittals:

1. Submit to the Consultant prior to commencement of the work, the following:
    a. Shop Drawings including the following information:
        i. Manufacturer's descriptive literature.
        ii. Plastic Pipe Installations: Output adjustment factors for heating cable for the services indicated.
        iii. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2. PRODUCTS

2.1 SYSTEM DESIGN REQUIREMENTS

A. Systems to be heat traced are identified on the Contract Drawings and are to provide freeze protection, rated for 120 Volt single phase.

2.2 ELECTRICAL HEATING CABLE

A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, copper and stainless steel pipe applications.

B. Freeze protection to maintain 10 degrees Celsius (C).

C. Minimum Ambient Temperature: Minus 30 degrees Celsius.

D. Service Voltage: 120 VAC.

2.3 CONNECTION SYSTEM

A. Rating: EEMAC Type 4X, and CSA approved. Classification according to the Drawings.

B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.

2.4 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.

2.5 AMBIENT THERMOSTAT

A. Type: Adjustable setting (minus 40 degrees Celsius to plus 40 degrees Celsius).

B. Sensor: Fluid-filled probe.

C. Enclosure: EEMAC Type 4X aluminum enclosure with exposed hardware of stainless steel. Classification according to the Drawings.

D. Switch: SPDT, CSA listed, rated 22 amps, 125 to 250 VAC.

PART 3. EXECUTION

3.1 INSTALLATION

A. General:

1. Install in accordance with the Manufacturer's instructions and recommended practices.

2. Ground metallic structures or materials used for support of heating cable or surfaces on which it is installed in accordance with the OESC.

3. Wiring between power connection points of heat tracing cable branch lines shall be provided by Heat Tracing System Supplier.

4. Provide end of circuit pilot lights on heat tracing circuits.

5. Provide all accessories required to connect and install a complete heat tracing system.

B. Electrical Heating Cable:

1. Determine required length of electrical heating cable by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating cable output.

2. Where design heating load exceeds heating cable capacity, install by spiraling.

3. De-rate heating cable capacity when installed on plastic piping.

C. Thermostats:

1. Install in accordance with the Manufacturer's instructions and as approved by the Consultant.

2. For each group of heat traced circuits, install one ambient thermostat.

3.2 FIELD QUALITY CONTROL

A. Test each circuit with a 500 volt insulation tester between circuit and ground with neutrals isolated from ground.

1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION