



**Request for Tender  
RFT-SM-008-26  
Glencoe Wastewater System Upgrades – Industrial  
Park Sewage Pump Station Upgrade**

**Tender** submissions must be received by the Manager of Public Works in a sealed envelope or package clearly marked with the Name and Address of the Proponent, Title of File and File Number. Submissions should be received not later than:

***2:00:00 p.m. LOCAL TIME, Wednesday, March 11, 2026***

Submissions received after the closing time will not be accepted. Proponents are solely responsible for ensuring Tender submissions are received prior to the closing date and time in the proper location. Complete submissions of Tenders, Quotations and Proposals are to be dropped off at:

**MUNICIPALITY OF SOUTHWEST MIDDLESEX  
153 McKELLAR STREET  
GLENCOE, ONTARIO, CANADA, N0L 1M0**

Tenders will be publicly opened in the Municipality of Southwest Middlesex, following tender close on the day of closing.

**Lowest or Any Tender Not Necessarily Accepted.**

**Optional pre-tender site visit will be held on Friday, February 27, 2026 at 11:00am at the Industrial Park Pump Station at 99 Industrial Road.**

**Tenders, Quotations and Proposals can now be viewed and/or downloaded from:  
<http://www.biddingo.com>**

## Tender Checklist

Make sure your tender submission is complete. The Tender Submission Package must be legible, neat and filled out in ink. Your bid is to include the following where applicable, but not limited to:

Items that must be submitted on Tender Closing	Completed
Form of Tender and Privilege Clause with Summary Sheet(s)	
Summary Form (Page 14 of Section C)	
List of References	
Agreement to Bond	
Signed Addendum/Addenda	
Bid Bond (10%)	

This Tender Checklist is provided for the convenience of Bidders.  
Bidders are advised to read and understand the entire tender document package.

## RETURN LABEL

Please firmly affix this address label to the envelope or package containing your submission.

-----  
Cut Here  
-----

Firm Name: \_\_\_\_\_

Address: \_\_\_\_\_

**RFT-SM-008-26:** Glencoe Wastewater System Upgrades – Industrial Park Sewage Pump Station Upgrade

Closing Date and Time: Wednesday, March 11, 2026 at 2:00:00 p.m., LOCAL TIME

**Manager of Public Works  
Municipality of Southwest Middlesex  
153 McKellar Street  
Glencoe, Ontario, N0L 1M0  
Canada**



**Request for Tender  
RFT-SM-008-26  
Glencoe Wastewater System Upgrades – Industrial Park Sewage  
Pump Station Upgrade**

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**SECTION A – INFORMATION TO BIDDERS**

## 1. Definitions

Throughout this Request for Tender, unless inconsistent with the subject matter or context, the following definitions shall apply:

- a. **"Addenda" or "Addendum"** - means a document containing additional information or changes to the Request for Tender issued by the Municipality prior to the closing date;
- b. **"Bid" or "Tender"** means an offer submitted by a Bidder or Tenderer in response to a Request for Tender, which includes all the documentation necessary to satisfy the submission requirements of the Request for Tender and "Bids" shall have a corresponding meaning;
- c. **"Bidder" or "tenderer"** means a legal entity, being a person, partnership or firm that submits a Bid in response to a formal Request for Tender and "Bidders" or "Tenderers" shall have a corresponding meaning;
- d. **"Closing date"** means the specified deadline for Bids to be submitted to the Municipality as indicated on the Request for Tender cover page and any subsequent addenda;
- e. **"Contract"** - means the agreement covering the performance of the work, including the supply of any and all work, labour, implements, and materials that could reasonably be required properly and satisfactorily to complete the work to be performed and includes the plans, specifications, contract bond and any written supplementary agreements that may be made in order to ensure the completion and maintenance of the work in an acceptable manner;
- f. **"Contract Administrator"** means the main contact person for all matters relating to the project. The reference to "Project manager" means the same;
- g. **"Contractor"** - means the person, partnership or corporation undertaking the execution of the work under the terms of the Contract;
- h. **"Council"** means the Municipality of Southwest Middlesex Council;
- i. **"Owner" or "Corporation"** - means the Municipality of Southwest Middlesex entering into the Contract with the Contractor;
- j. **"Inspector"** - means any person, partnership or corporation that the Municipality or Engineer/Consultant may appoint for the purpose of assisting in the supervision and inspection of the work and the materials to be used in the work;
- k. **"Municipality"** - means the Municipality of Southwest Middlesex;
- l. **"Plans"** - means any drawing or reproduction of drawing pertaining to the work;
- m. **"Request for Tender"** means this Request for Tender package in its entirety, inclusive of all appendices and Addenda/Addendum that maybe issue by the Municipality;
- n. **"Specification"** - means all written descriptions or instructions pertaining to the method and manner of performing the work, or to the quantities and qualities of the materials to be furnished under the Contract, and includes the Tender, General Conditions, Standard Specifications, Supplemental Specifications and Special

Provisions, together with all written agreements, made or to be made pertaining to the method or manner of performing the work, or to the quantities or qualities of materials to be furnished under the Contract;

- o. **"Standard Specifications"** - means the requirements and stipulations of standard practice by the Municipality for the control of work;
- p. **"Supplemental Specifications"** - means the specifications, supplemental to the standard specifications and containing requirements peculiar to the work;
- q. **"Special Provisions"** - means special directions containing requirements peculiar to the work not adequately provided for by the standard or supplemental specifications;
- r. **"Sub-Contractor"** - means a person, partnership or corporation undertaking the execution of a part of the work by virtue of an agreement between himself and the Contractor, and who has independent control over the work to be done under such agreement;
- s. **"Work" or "Works"** (unless the context requires a different meaning) - means the whole of the works, materials, matters and things required to be done or supplied, mentioned or referred to in the tender, specifications, plans, profiles, and drawings including all extra or additional work or materials, matters or things which may be ordered by the Engineer/Consultant; and
- t. The words **"Approval"**, **"Directed"**, **"Required"**, **"Considered Necessary"**, **"Authorized"**, **"Acceptable"**, **"Satisfactory"**, **"Provide"**, or words of like import, shall mean approval of, directed, required, considered necessary or authorized by and acceptable or satisfactory to the Contract Administrator.

## 2. Job Description

The general objective of the project is to upgrade the Industrial Park Sewage Pump Station (SPS) to increase pumping capacity, in conjunction with the installation of a new 200mm diameter forcemain, to connect to an existing 350mm forcemain. This project includes, but is not limited to the following:

- Construction of new valve chamber complete with new piping, flow meter, valves, and drainage system.
- Installation of two (2) new submersible pumps (lead/lag operation), supply and installation of piping and valves within the wet well, and related electrical instrumentation.
- Wet well upgrades, including but not limited to installation of a new wet well cover, new pump and manway hatches and other elements as indicated.
- Installation of new generator and electrical equipment for new pumps, including upgrade to natural gas service line.
- Temporary pumping system (duty and standby required) to allow for bypass of flows from the existing manhole (upstream of the wet well on Industrial Road) to the existing valve chamber, including valving and temporary bypass piping, and required upstream/downstream connections, and temporary plugging of the interconnection between the wet well and manhole.
- Removal of existing submersible pumps and related equipment in the wet well.

- Connection to new forcemain stub as indicated on the drawings.
- Commissioning of new system (SPS with new forcemain).
- Removal of temporary pumping system after the new system is approved and properly operating.
- Removal of existing generator.
- Decommissioning of existing valve chamber following commissioning of new valve chamber and pumping system, including removal of equipment and piping, removal of chamber lid and demolition of walls minimum 0.6 m below grade including backfill of chamber with sand, followed by restoration at surface with topsoil and seed.
- Complete final site civil and landscaping works including installation of new fencing.
- All other required works to construct a complete sanitary pumping station operating as intended as per the design contained in the Specifications and Contract Drawings.

### **3. Delivery of Tenders**

Completed tender form packages shall be submitted in sealed envelope/package marked:

**“Tender RFT-SM-008-2026: Glencoe Wastewater System Upgrades – Industrial Park Sewage Pump Station Upgrade”**

Tenders will be received until 2:00 p.m., local time, on **Wednesday, March 11, 2026**, at:

153 McKellar Street, Glencoe, ON, Canada, N0L 1M0

The lowest or any bid may not necessarily be accepted.

### **4. Disqualification of Tenders**

Tenders that are not received prior to the advertised closing time, or are conditional in any part, will be deemed incomplete. The bidding system will not allow incomplete tenders to be submitted.

### **5. Omissions, Discrepancies, Questions and Conflicts of Interest**

Should a bidder find discrepancies in, or omissions from, the drawings or contract documents or should he be in doubt as to their meaning, they should notify the Contract Administrator. All questions concerning this Request for Tender should be directed in writing to the following:

**Contract Administrator:** Stantec Consulting Ltd.  
**Contact:** Nelson Oliveira, P.Eng.  
**Email:** nelson.oliveira@stantec.com

No other representative, whether an official, agent or employee, is authorized to speak for the Municipality with respect to this Request for Tender, and any bidder who uses any information, clarification or interpretation from any other representative does so entirely at the Bidder's own risk.

Not only shall the Municipality not be bound by any representation made by an unauthorized person, but any attempt by a Bidder to bypass the Request for Tender Process may be grounds for rejection of its Bid.

In the event of any discrepancies whatever or ambiguity of any symbol, note, abbreviation, etc. used in the Specifications or on the Contract Drawings, the Contractor shall obtain clarification from the Contract Administrator prior to submitting his tender.

Written requests will be considered, following which, the Manager of Public Works or Contract Administrator may issue an addendum. All questions must be received by the Municipality by Wednesday, March 4, 2026 no later than 2:00 pm.

## **6. Contract Period**

The term of the contract will be for a period from contract award to project completion and end of warranty. **Substantial Completion is required by March 19, 2027.** The contractor once mobilized at the project site is to remain on site and continue work until the work is substantially complete.

## **7. Withdrawal or Qualifying of Tenders**

A tenderer, who has already submitted a tender, may submit a further tender at any time up to the closing time. The last tender received shall supersede and invalidate all tenders previously submitted by that bidder for this contract.

A tenderer may withdraw or qualify his tender at any time up to the closing time by submitting a letter bearing their signature and seal showing his name and the project and contract numbers on the envelope containing such letter. No other forms of communication will be considered.

## **8. Method of Measurement and Payment**

The Municipality is seeking firm prices for the contract period as indicated. The Contractor shall review the specifications and drawings in order to develop their estimates on labour, material, and other related costs. Lump sum prices must include all applicable fees, levies, and surcharges (i.e., fuel surcharges, environmental fees, commodity surcharges, disposal fees, paper invoice charges, etc.).

Measurement of finished work and method of payment shall be as per OPSS or as specifically indicated in the Specifications.

## **9. Harmonized Sales Tax (HST)**

The contractor will indicate the Harmonized Sales Tax (HST) as are applicable.

Any change in the tax structure that exists at the time of signing will be paid or deducted, as the changes become law.

The contractor must provide the H.S.T. registration number.

## **10. Informal or Unbalanced Tenders, Informalities**

Informalities or irregularities noted during the tender opening, or during the review of tenders, will be forwarded to the Municipality of Southwest Middlesex Manager of Public Works, or designate for a ruling on whether the informality compromises the tendering process. This ruling will not necessarily happen at the tender opening. The Manager of Public Works will decide whether to accept or reject any tender for such informalities after completion of the tender openings. **See Item 11 below for cases where tenders will be automatically rejected during the tender opening.**

Tenders that contain prices which appear to be so unbalanced as likely to adversely affect the interests of the owner may be rejected.

If a tenderer has omitted to enter a price for an item of work set out in the Form of Tender, they shall be deemed to have allowed elsewhere in the tender for the cost of carrying out the said item of work.

## **11. Acceptance of Tenders**

The tender for this project will be submitted to the Municipality of Southwest Middlesex.

The Municipality reserves the right to reject any or all tenders or to accept any tender should it be deemed in the interest of the Municipality to do so.

The following will be cause for the rejection of tenders:

1. Invalid / No agreement to bond documentation.
2. Invalid / No tender deposit attached or enclosed.
3. Invalid/ No supporting information (supervisory personnel, experience, proposed suppliers, construction plant) included.
4. Signed Addenda not attached to Form of Tender
5. The privilege clause not signed.
6. Form of Tender not signed and sealed.

If any of the above are noted to be missing or incorrect, the tender price will not be unsealed.

The deposit of the bidder whose tender is accepted will be forfeited by him to the Owners as liquidated damages should the tenderer fail to execute a contract within 14 days after being notified in writing by the Contract Administrator of the acceptance of his tender, or to supply a satisfactory bond as stipulated in the General Conditions.

The deposits of the unsuccessful tenderers, except for the two (2) low bids, will be returned without interest within three (3) working days after tender opening.

All deposits will be returned without interest upon execution of a contract with the successful tenderer or should a contract not be executed within sixty (60) days of the date of closing of this tender.

## **12. Document Required Before Tender Closing**

Tenderers must submit the following information before tender closing:

- i) The bidder must fill in and submit the unbound section of the Form of Tender. This includes Contractor's experience and supervisory personnel, subcontractor's experience and supervisory personnel (if applicable), a listing of all proposed suppliers and a listing of all construction equipment to be used.
- ii) **Tender Deposit:** The Tender shall be accompanied by a Bid Deposit by way of a bid bond, certified cheque, bank draft, irrevocable letter of credit or money order, in its original form, in the amount of 10% of the total bid price including all taxes, made payable to the Municipality of Southwest Middlesex.
- iii) Proposed schedule of construction showing completion of the work in accordance with the working days specified.
- iv) Acknowledgement of Addendum/Addenda

## **13. Documents Required at Contract Signing**

Prior to signing of the Contract, the Municipality shall require submission by the contractor of the following documents:

- a) Executed Contract
- b) Compliance with Section 7 and 80.49 of Ontario Regulation 191/11 [Accessibility for Ontarians with Disabilities Act (AODA)]
- c) Insurance documents in compliance with the Bid Request
  - i. Commercial General Liability \$5,000,000;
  - ii. Automobile \$2,000,000;
  - iii. Environmental Liability/Contractor's Pollution Liability \$5,000,000
- d) Workplace Safety and Insurance Board (WSIB) Certificate
- e) Executed Bonds
  - i. 100% Performance Bond

- ii. 100% Labour and Materials Payment Bond
- f) A copy of the Successful Bidder's Health and Safety Policy
- g) Copy of Notification of Contract as transmitted to Ministry of Labour
- h) Construction Schedule
- i) Confined Space Entry Policies and Procedures
- j) Hot Work Policies and Procedures
- k) Contractor Health and Safety Policy

#### **14. Standard Specifications and Drawings**

The purpose of this Request for Tender ("RFT") is to obtain bid submissions ("Bids") for the upgrades to the Industrial Park Sewage Pump Station for The Municipality of Southwest Middlesex ("the Municipality") in accordance with OPSD, OPSS, Municipal Design Standards, Special Provisions, and Specifications provided as part of this tender package. Other standard specifications and drawings may also be referenced in this contract.

#### **15. Addendum and Addenda**

Proponents shall acknowledge receipt of any addenda when submitting their Proposal.

Addendum/Addenda will be issued through the Bidding System, up to three (3) days prior to Closing Time and Date. However, the municipality may still issue an addendum for administrative corrections or clarifications within three (3) business days prior to closing date.

In the event an addendum is issued within three (3) days prior to Closing Time and Date, it may include an extension of the Closing Time and Date. It is the responsibility of the Proponent to have received all Addendum/Addenda that have been issued.

The municipality encourages Proponents **not** to submit their Bid prior to three (3) days before the Proposal closing time and date, in the event that an addendum is issued. If a Proponent submits their bid prior to this or at any time prior to the bid closing and an addendum/addenda is issued, the municipality may, at its sole discretion, disqualify the bid based on incomplete submission. The Proponent is solely responsible to:

- i) make any required adjustments to their Bid; and
- ii) acknowledge the addendum/addenda; and
- iii) Ensure the re-submitted Bid is received by the municipality no later than 2:00:00pm (local time), on the Bid Closing Date.

#### **16. Provision for Traffic**

Traffic control plans must be submitted to the Contract Administrator for approval prior to construction and any subsequent changes must be approved in writing.

Signage and traffic control to be in accordance with the Ontario Traffic Manual – Book 7.

### **17. Pre-tender Site Visits**

An optional pre-tender site visit will be held on Friday, February 27, 2026 at 11:00 am at the Industrial Park SPS located at 99 Industrial Road in Glencoe, ON.

### **18. Environmental Protection**

All environmental protection measures will be governed by the requirements of the Ontario Ministry of the Environment, Conservation and Parks (MECP) and the local Conservation Authority.

### **19. Geotechnical Investigation**

A geotechnical investigation was not undertaken for this project.

**SECTION B – SUPPLEMENTARY CONDITIONS**

The latest version of the Ontario Provincial General Conditions (GC) shall form part of this contract. Amendments to the GC are noted herein.

### **1. Testing of Material**

Section GC5.02 of the General Conditions of Contract is hereby amended and/or extended.

The Contract Administrator may require documentary evidence to the effect that materials supplied by the Contractor comply with the specifications, in the form of a certified copy of a laboratory report from a testing company acceptable to the Contract Administrator. No costs in connection with these tests shall be borne by Municipality of Southwest Middlesex.

### **2. Insurance**

Section GC6.03 of the General Conditions is hereby amended/extended.

The face value of the general liability insurance shall be five million dollars (\$5,000,000).

The insurance shall be maintained continuously from the commencement of the work until twelve months following the date of final acceptance.

The Contractor shall submit to the owner, proof of insurance for the guarantee period. This proof shall be submitted prior to the release of final holdback.

#### **The following shall be named as Additional Insured:**

- Municipality of Southwest Middlesex

### **3. Definition of a Working Day**

Notwithstanding section GC1.04 of the General Conditions (GC) of the contract, a working day is any weekday from 7:00 a.m. to 7:00 p.m. All work must be completed within this timeframe.

### **4. Progress of the Work and Time for Completion**

Section GC7.01 of the General Conditions is hereby amended/extended.

The work under the contract must commence on the date stated in the Schedule of Construction, and must be diligently prosecuted in general accordance therewith, so that the work is completed within the specified times.

The Contractor will work additional and/or augmented daylight shifts as may be required to ensure that the work will be completed within the time limit specified, and no additional compensation will be allowed therefor.

## 5. Liquidated Damages

In the event that this contract is not completed within the time as set forth in the Special Provisions, or as extended in accordance with the General Conditions, the Contractor will pay Municipality of Southwest Middlesex Centre the sum of **\$1,500.00 as liquidated damages** for each and every calendar days delay in finishing the work in excess of the time prescribed.

## 6. Progress Payments and Holdbacks

Section GC8.02 of the General Conditions (GC) is amended by the following:

- i) All payments, holdbacks and releases of holdbacks shall be subject to the Construction Act and the conditions set out in Section 8 of the general conditions and the additional conditions listed below.
- ii) The Municipality will issue one copy of a progress payment certificate, which the Contractor has, signified approval, for payment every month. These progress payment certificates will be subject to a Lien holdback in the amount of 10% of the total estimated value of work completed to date and 2.5% Maintenance Holdback.
- iii) Forty-five (45) calendar days after publication of the Substantial Performance Certificate, provided that no claims have been filed in accordance with the Construction Act and a Certificate of Publication of the Substantial Performance Certificate is available, the Municipality will issue an up-to-date payment certificate and release the 10% Lien holdback but 2.5% Maintenance Holdback of the total estimated value of the work will be retained for the duration of the maintenance period.
- iv) A second substantial performance certificate will be issued for publication if the amount of work completed at that time was revised to issue the first substantial performance certificate. Except for the 2.5% maintenance holdback and provided no lien has been filed, the balance of the lien amount will be release after an additional 45 calendar days after publication of the Second Substantial Performance Certificate.
- v) Final payment, including release of all holdback, will be made by the Municipality to the Contractor within thirty days after the Contractor has submitted the following documents:
  - i) one copy of the final payment certificate on which the Contractor has signified approval of the quantities and values contained therein.

- ii) the Contractor's statutory declaration that all sub-Contractors and suppliers have been paid.
- iii) signed releases from owners of all private property used by the Contractor during construction of the work.
- iv) a Workplace Safety and Insurance Board Certificate.
- v) a Standby Irrevocable Letter of Credit (LC), in favour of the Municipality for 2.5% of the contract amount, from a Canadian Chartered Bank, in lieu of the 2.5% Maintenance holdback.
- vi) proof of Insurance for the term of the maintenance period.

## **7. Guarantee Maintenance**

The guarantee maintenance period for the contract shall commence on the date of acceptance of the completed work and shall continue for a period of twelve (12) months for the entire project.

The Municipality will conduct an inspection with the Contractor before the expiry of the twelve (12) month maintenance warranty period. Any deficiencies found during this inspection, or at any time during the warranty period, shall be corrected by the Contractor at his/her expense within thirty (30) days after being notified by the Municipality.

Should the Contractor fail to repair any deficiency within the prescribed time, or should the Municipality deem a deficiency to need emergency repair during the warranty period, the Municipality will pay for the repair by drawing from the Letter of Credit or from the maintenance holdback, after giving the Contractor 24 hours notice.

## **8. Specifications and Drawings**

Ontario Provincial Standard Specifications and Ontario Provincial Standard Drawings are to be read with and form part of this contract. Other specifications and drawings are also referenced to in this contract.

## **9. Disposal of Materials**

All unsuitable materials or excess materials to the contract shall be disposed of by the Contractor at his/her risk and expense. The Contractor shall submit copies of the signed releases from Owners of all disposal sites.

## **10. Contractor's Meetings**

The Contractor will attend and cause his sub-contractors, if any, to attend any meetings called by the Contract Administrator or the Municipality to discuss the progress of the work under this contract at no extra cost to the Municipality.

## **11. Utilities**

Section GC 2.01 of the General Conditions of the contract is hereby amended:

The location of the utilities shown on the plans is approximate only. The Contractor will obtain the necessary locates prior to proceeding with the work.

## **12. Subcontractors**

Section GC3.09 of the General Conditions of the contract is hereby extended:

The Contractor may not subcontract more than 50% of the dollar value of the contract.

## **13. Order of Precedence**

Section GC2.02 of the General Conditions is hereby extended and/or amended.

- a) Agreement
- b) Addenda
- c) Supplementary specifications
- d) Special provisions
- e) Contract drawings
- f) Standard specifications
- g) Tender
- h) Supplemental general conditions
- i) General conditions

## **14. Variations in Tender Quantities**

Not applicable.

## **15. Construction Document Sets (Specifications and Drawings)**

The Municipality will only issue digital drawings of Construction Drawings and Specifications to the successful Contractor(s). Contractors shall make additional copies of the Construction Drawings and Tender Specifications.

Refer to Division 1 for a suggested construction staging plan that may be followed to ensure the functionality of the facility is not impeded during construction. However, it is the Contractor's responsibility to develop the final construction staging plan meeting the required objective of uninterrupted and undisturbed operation. The Contractor must submit a copy of this plan to the Contract Administrator for review, a minimum of two (2) weeks prior to beginning construction.

**SECTION C – FORM OF TENDER**

**Checklist of Items Required with Bid Submissions:**

- Form of Tender – completed, signed and initialed where indicated
- Tender Document Privilege Clause
- Summary Form (Page 14 of Section C)
- List of References (Page 5 of Section C)
- Agreement to Bond
- Bid Bond (10%)
- Addendum/Addenda

**Checklist of Items Required within 24 Hours of Request of Lowest Bidders:**

- 24-Hour Breakdown Pricing (Pages 11 to 13 of Section C)
- List of subcontractors to be employed (Page 6 of Section C)
- Statement A, Contractor and Subcontractor's Experience
- Statement B, relative to supervisory personnel I/we propose to assign to the project, (including subcontractors).

**Checklist of Items Required Prior to Commencement of Work:**

- Executed copies of the Agreement
- Proposed preliminary schedule of construction
- Insurance certificates in compliance with Tender documents
- Copy of notification of Contract as sent to Ministry of Labour
- Copy of Contractor's Health and Safety Policy
- All required bonding as listed in the Tender Documents



**Form of Tender  
RFT-SM-008-26  
Glencoe Wastewater System Upgrades – Industrial Park Sewage  
Pump Station Upgrade**

From: \_\_\_\_\_  
(Contractor)

To: Mayor and Members of the Council of the Municipality of Southwest Middlesex

I (We), the undersigned, have carefully examined the locality and site of the proposed construction described above, and all documents relating thereto including Addendum/Addenda, and I/we hereby, if successful, intend to enter into a contract with the Municipality of Southwest Middlesex to construct the said works, in strict accordance with the Contract Documents, for the estimated total contract price of:

\_\_\_\_\_  
\_\_\_\_\_ Canadian dollars (\$\_\_\_\_\_)  
inclusive of all taxes.

The aforesaid sum is made up as shown in the schedule of items and prices which has been completed and attached hereto, and which shall form the basis of payment for the contract.

**\*The Tenderer will insert here (\*\_\_\_\_\_) the numbers of addenda received by him during the tender period and taken into account by him in preparing this tender.**

The tenderer agrees that the prices provided may be released to the public in accordance with the Municipal Freedom of Information and Protection of Privacy Act.

I/we hereby acknowledge my/our agreement to the terms and conditions contained in the Information to Bidders.

Dated this \_\_\_\_\_ day of \_\_\_\_\_, **2026.**

\_\_\_\_\_  
(Contractor)

\_\_\_\_\_  
(Signature)

\_\_\_\_\_  
(Name)

\_\_\_\_\_  
(I / We have the authority to bind the Corporation / Firm)

\_\_\_\_\_  
(Address)

\_\_\_\_\_  
(City and Province)

\_\_\_\_\_  
(Postal Code)

\_\_\_\_\_  
(HST Reg. #)

\_\_\_\_\_  
(Telephone)

\_\_\_\_\_  
(Fax)



### List of References

Please provide the information requested below. Reference checks will be completed and the decision to award the tender will be based on the Municipality of Southwest Middlesex's assessment of overall qualified low bidder. Experience listed below must be relevant to the current project in scope and value. If there is additional information you wish to provide with regard to references, please do so on the reverse of this sheet.

Project Name	
Company for whom the work was complete:	
On the project did your firm act as	General Contractor <input type="checkbox"/> Subcontractor <input type="checkbox"/>
What was the value of the project or your portion of the project?	\$
Contact Name at the owner's facility	
Telephone Number with area code	
Date of Completion of this project	

Project Name	
Company for whom the work was complete:	
On the project did your firm act as	General Contractor <input type="checkbox"/> Subcontractor <input type="checkbox"/>
What was the value of the project or your portion of the project?	\$
Contact Name at the owner's facility	
Telephone Number with area code	
Date of Completion of this project	

Project Name	
Company for whom the work was complete:	
On the project did your firm act as	General Contractor <input type="checkbox"/> Subcontractor <input type="checkbox"/>
What was the value of the project or your portion of the project?	\$
Contact Name at the owner's facility	
Telephone Number with area code	
Date of Completion of this project	





**General Contractor:**

**Statement “B” – Supervisory Personnel to be Employed**

The two lowest Bidders must provide a listing of key supervisory personnel who will be employed on the project upon request. **(An attachment is acceptable)**

**(a) Prime Contractor**

<b>Name</b>	<b>Position</b>	<b>Qualification and Experience</b>

**(b) Subcontractors – (An attachment is acceptable)**

<b>Name</b>	<b>Position</b>	<b>Qualification and Experience</b>

This list is subject to the approval by Municipality of Southwest Middlesex, and once approved by Contract Award, may not be changed without the Municipality's written consent. The successful Contractor shall make the above request in writing to the Contract Administrator and the Municipality of Southwest Middlesex.

## **Proposed Schedule of Construction**

The Contractor must submit a realistic schedule of construction prior to commencement of work.

**Note: Prior to Contract Award, the Contractor will be required to confirm that the time restrictions as described in the Special Provisions will be adhered to.**

## **Schedule of Items and Prices**

The tendered prices shall allow for all work required by the Contract whether specifically covered or not by the items of this Schedule. **The 16 Division Price Summary Form is to be completed and submitted at time of tender close.**

If, in the opinion of the Engineer, the breakdown contains prices, which are unbalanced, the tenderer will be required to submit data to substantiate his/her prices. In any event, the Engineer reserves the right to adjust the breakdown to correct any unbalanced prices. Prices include supply, installation, testing, commissioning, training, etc., to complete final products, as specified.

**24 - HOUR BREAKDOWN PRICING**  
**Industrial Park SPS Upgrades**  
**Tender Number RFT-SM-008-26**

**SECTION 1 - INDUSTRIAL PARK SPS UPGRADE**

**DIVISION 1 GENERAL:**

1.1 MOBILIZATION & DEMOBILIZATION	ls	1	\$ -	\$ -
1.2 PERFORMANCE BONDS	ls	1	\$ -	\$ -
1.3 SCHEDULE, DAILY RECORDS AND MONTHLY REPORTS	ls	1	\$ -	\$ -
1.4 LABOUR & MATERIAL BONDS	ls	1	\$ -	\$ -
1.5 INSURANCE	ls	1	\$ -	\$ -
1.6 PERMITS	ls	1	\$ -	\$ -
1.7 PROJECT SIGNAGE	ls	1	\$ -	\$ -
1.8 SHOP DRAWINGS	ls	1	\$ -	\$ -
1.9 RECORD DRAWINGS	ls	1	\$ -	\$ -
1.10 COMMISSIONING OF INDIVIDUAL EQUIPMENT	ls	1	\$ -	\$ -
1.11 OPERATION & MAINTENANCE MANUALS	ls	1	\$ -	\$ -
1.12 PRE-START HEALTH AND SAFETY REVIEWS	ls	1	\$ -	\$ -
1.13 OTHER ITEMS REQ'D TO COMPLETE DIV 1	ls	1	\$ -	\$ -
<b>TOTAL DIVISION 1</b>			<b>\$ -</b>	<b>\$ -</b>

**DIVISION 2 SITE CONSTRUCTION:**

2.1 GENERAL SITE ITEMS	ls	1	\$ -	\$ -
2.2 DRAINAGE	ls	1	\$ -	\$ -
2.3 EXCAVATION	ls	1	\$ -	\$ -
2.4 BACKFILL	ls	1	\$ -	\$ -
2.5 UNDERGROUND PIPING	ls	1	\$ -	\$ -
2.6 PAVING AND SERVICING	ls	1	\$ -	\$ -
2.7 FENCING AND GATES	ls	1	\$ -	\$ -
2.8 SITE GRADING	ls	1	\$ -	\$ -
2.9 ROADWORKS	ls	1	\$ -	\$ -
2.10 DEWATERING	ls	1	\$ -	\$ -
2.11 LAWN & GRASS	ls	1	\$ -	\$ -
2.12 RESTORATION	ls	1	\$ -	\$ -
2.13 DEMOLITION	ls	1	\$ -	\$ -
2.14 OTHER ITEMS REQ'D TO COMPLETE DIV 2	ls	1	\$ -	\$ -
<b>TOTAL DIVISION 2</b>			<b>\$ -</b>	<b>\$ -</b>

**DIVISION 3 CONCRETE:**

3.1 CONCRETE ACCESSORIES	ls	1	\$ -	\$ -
3.2 CAST-IN-PLACE CONCRETE INCL. REINFORCEMENT	ls	1	\$ -	\$ -
3.3 PRE-CAST CONCRETE SPECIALTIES	ls	1	\$ -	\$ -
3.4 MUD MAT	ls	1	\$ -	\$ -
3.5 EQUIPMENT BASES	ls	1	\$ -	\$ -
3.6 CONCRETE FINISHES	ls	1	\$ -	\$ -
3.7 OTHER ITEMS REQ'D TO COMPLETE DIV 3	ls	1	\$ -	\$ -
<b>TOTAL DIVISION 3</b>			<b>\$ -</b>	<b>\$ -</b>

**DIVISION 5 METALS:**

5.1 METAL FABRICATIONS	ls	1	\$ -	\$ -
5.2 WET WELL COVER AND HATCHES	ls	1	\$ -	\$ -
5.3 OTHER ITEMS REQUIRED TO COMPLETE DIVISION 5	ls	1	\$ -	\$ -
<b>TOTAL DIVISION 5</b>			<b>\$ -</b>	<b>\$ -</b>

**24 - HOUR BREAKDOWN PRICING**  
**Industrial Park SPS Upgrades**  
**Tender Number RFT-SM-008-26**

**DIVISION 7 WATERPROOFING**

7.1 MEMBRANE WATERPROOFING	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 7</b>	<b>\$ -</b>

**DIVISION 11 EQUIPMENT:**

11.1 PUMPS	ls	1	\$ -	\$ -
11.2 OTHER ITEMS REQ'D TO COMPLETE DIV 11	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 11</b>	<b>\$ -</b>

**DIVISION 13 SPECIAL CONSTRUCTION:**

13.1 MAINTAINING FACILITY OPERATIONS INCL BYPASS PUMPING	ls	1	\$ -	\$ -
13.2 OTHER ITEMS REQ'D TO COMPLETE DIV 13	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 13</b>	<b>\$ -</b>

**DIVISION 14 CONVEYING EQUIPMENT:**

14.1 HOISTS	ls	1	\$ -	\$ -
14.2 OTHER ITEMS REQ'D TO COMPLETE DIV 14	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 14</b>	<b>\$ -</b>

**DIVISION 15 MECHANICAL:**

15.1 PROCESS PIPING	ls	1	\$ -	\$ -
15.2 PROCESS VALVES	ls	1	\$ -	\$ -
15.3 PIPE SUPPORTS	ls	1	\$ -	\$ -
15.4 PLUMBING AND DRAINAGE	ls	1	\$ -	\$ -
15.5 PROCESS PIPING TESTING	ls	1	\$ -	\$ -
15.6 GAUGES	ls	1	\$ -	\$ -
15.7 OTHER ITEMS REQ'D TO COMPLETE DIV 15	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 15</b>	<b>\$ -</b>

**DIVISION 16 ELECTRICAL:**

16.1 ELECTRICAL SERVICES	ls	1	\$ -	\$ -
16.2 ELECTRICAL DISTRIBUTION	ls	1	\$ -	\$ -
16.3 STANDBY GENERATOR, COMPLETE	ls	1	\$ -	\$ -
16.4 WIRING AND WIREWAYS	ls	1	\$ -	\$ -
16.5 BUILDING SERVICES ELECTRICAL	ls	1	\$ -	\$ -
16.6 INSTRUMENTATION	ls	1	\$ -	\$ -
16.7 PLC/SCADA CONTROL PANEL	ls	1	\$ -	\$ -
16.8 VARIABLE FREQUENCY DRIVES	ls	1	\$ -	\$ -
16.9 OTHER ITEMS & REMOVALS REQ'D TO COMPLETE DIV 16	ls	1	\$ -	\$ -
			<b>TOTAL DIVISION 16</b>	<b>\$ -</b>

**CASH ALLOWANCE:**

17.1 SCADA ALLOWANCE	<b>Allowance</b>	\$ 50,000.00
17.2 GEOTECHNICAL ALLOWANCE	<b>Allowance</b>	\$ 7,500.00
17.3 EQUIPMENT ALLOWANCE	<b>Allowance</b>	\$ 67,500.00
17.4 VACUUM TRUCK ALLOWANCE	<b>Allowance</b>	\$ 5,000.00
		<b>TOTAL CASH ALLOWANCE</b>
		<b>\$ 130,000.00</b>

**SECTION 2 BOOSTER PUMPING STATION SUBTOTAL**

24 - HOUR BREAKDOWN PRICING  
Industrial Park SPS Upgrades  
Tender Number RFT-SM-008-26

## SUMMARY

<b><u>SECTION 1 - INDUSTRIAL PARK SPS UPGRADE</u></b>	\$	-
<b><u>SECTION 2 - CONTINGENCY ALLOWANCE</u></b>	\$	100,000.00
<b>SUB-TOTAL TENDER PRICE (EXCL. HST)</b>	\$	-

**Municipality of Southwest Middlesex  
Glencoe Wastewater System Upgrades – Industrial Park Sewage Pump Station  
Upgrade  
RFT-SM-008-26**

**Summary Form**

(To be submitted by all bidders at Tender Closing)

<b>Division 1: General</b>	<b>\$</b>	
<b>Division 2: Site Construction</b>	<b>\$</b>	
<b>Division 3: Concrete</b>	<b>\$</b>	
<b>Division 5: Metals</b>	<b>\$</b>	
<b>Division 7: Waterproofing</b>	<b>\$</b>	
<b>Division 11: Equipment</b>	<b>\$</b>	
<b>Division 13: Special Construction</b>	<b>\$</b>	
<b>Division 14: Conveying Equipment</b>	<b>\$</b>	
<b>Division 15: Mechanical</b>	<b>\$</b>	
<b>Division 16: Electrical</b>	<b>\$</b>	
<b>Cash Allowance</b>	<b>\$</b>	130,000
<b>Contingency</b>	<b>\$</b>	100,000
<b>Sub-Total Contract Price</b>	<b>\$</b>	
<b>HST</b>	<b>\$</b>	
<b>Total Contract Price*</b>		
<b>Canadian Funds (including all applicable taxes)</b>	<b>\$</b>	

\*The Total Contract Price is to be entered on Page 2 of Form of Tender Section C.

TENDERER'S SIGNATURE: \_\_\_\_\_

**SECTION D – FORM OF AGREEMENT**

## Agreement

This Agreement made in duplicate this \_\_\_\_\_ day of \_\_\_\_\_, **2026**

Between:

hereinafter called the "Contractor"  
Of the First Part

And

**The Municipality of Southwest Middlesex**

hereinafter called the "Municipality"  
OF THE SECOND PART

WITNESSETH that the contractor hereby agrees to furnish all necessary machinery, tools, equipment, materials, supplies, labour and other means of construction, except as herein otherwise specified, to complete, in strict accordance with the plans and specifications, the work known as:

**Glencoe Wastewater System Upgrades – Industrial Park SPS Upgrade  
SM-008-26**

**and as described in the Contract Documents.**

In Consideration, the Municipality of Southwest Middlesex agrees to pay the contractor for all work done, in the manner provided by the specifications of this contract, the unit prices submitted by the contractor in the Form of Tender and accepted by the Municipality of Southwest Middlesex.

In Witness Whereof the Contractor and the Municipality of Southwest Middlesex have signed below.

Municipality of Southwest Middlesex

\_\_\_\_\_

\_\_\_\_\_  
(I / We have the authority to bind the Corporation / Firm)

**SECTION D – ACCESSIBILITY ACT**

### **Accessibility for Ontarians With Disabilities Act (AODA)**

In accordance with Ontario Regulation 191/11, Integrated Accessibility Standards Regulation, as amended, the Municipality is required to ensure all third parties or persons who provide goods, services or facilities on its behalf receive training. Contracted employees, third party employees, agents, and others who deal with members of the public on behalf of the Municipality must meet requirements of Ontario Regulation 191/11, as amended, with regard to training.

Prior to the commencement of any work under this contract the Contractor shall furnish evidence of compliance with the requirements of Section 6 of Ontario Regulation 429/07, Accessibility Standards for Customer Service, under the *Accessibility for Ontarians with Disabilities Act, 2005*.

**SECTION E – SPECIFICATIONS**

**DIVISION 1**  
**GENERAL REQUIREMENTS**

## **Division 1 General - Index**

*01010 Summary of Work*

*01013 Documents*

*01015 Contractor's Use of Premises*

*01020 Allowances*

*01025 Measurement and Payment*

*01035 Modifications*

*01060 Regulatory Requirements*

*01080 Identification Systems*

*01200 Project Meetings*

*01210 Prestart Health and Safety Report*

*01300 Submittals*

*01301 Shop Drawing Check List*

*01420 Inspection*

*01500 Construction Facilities and Temporary Controls*

*01545 Safety Requirements*

*01585 Site Environmental Management*

*01600 Materials*

*01650 Safety Review, Equipment Commissioning and Training*

*01650-A Manufacturer's Installation Certification Form*

*01650-B Pre-Commissioning Certification Form*

*01660 Special Project Procedures*

*01680 Physical Checkout-Shop and Field Testing*

*01700 Contract Closeout*

*01730 Operation and Maintenance Manuals*

*01780 Closeout Submittals*

**End of Section**

## 01010 Summary of Work

### 1.0 General

#### 1.1 Scope of Work

- .1 The following is a general but not necessarily complete description of the work and services to be provided under this contract. All the products and services mentioned or shown in the documents shall be provided, including all the incidentals necessary for a complete and working system to the satisfaction of the Engineer.
- .2 The existing Industrial SPS (sewage pumping station) will be upgraded to increase the pumping capacity of this facility and will be connected to a new forcemain (scope contract by others) between Industrial Park SPS and the Glencoe Wastewater Treatment Facility.
- .3 Construction work for the Industrial SPS upgrades includes the following components, all as specified herein and shown on the Contract Drawings, including, but not limited to:
  - .1 Construction of new valve chamber complete with new piping, flow meter, valves, and drainage system.
  - .2 Installation of two (2) new submersible pumps (duty/standby operation), supply and installation of piping and valves within the wet well, and related electrical instrumentation.
  - .3 Wet well upgrades, including but not limited to installation of a new wet well cover, new pump and manway hatches and other elements as indicated.
  - .4 Installation of new generator and electrical equipment for new pumps, including upgrade to natural gas service line.
  - .5 Temporary pumping system (duty and standby required) to allow for bypass of flows from the existing manhole (upstream of the wet well) to the existing valve chamber, including valving and temporary bypass piping, and required upstream/downstream connections, and temporary plugging of the interconnection between wet well and manhole.
  - .6 Removal of existing submersible pumps and related equipment in the wet well.
  - .7 Installation of new 200mm forcemain including connection to forcemain stub as indicated on the drawings, including new direct-buried air release valve.
  - .8 Commissioning of new system (SPS with new forcemain).
  - .9 Removal of temporary pumping system after the new system is approved and properly operating.
  - .10 Decommissioning of existing valve chamber following commissioning of new valve chamber and pumping system, including removal of equipment and piping, removal of chamber lid and demolition of walls minimum 0.6 m below grade including backfill of chamber with sand, followed by restoration at surface with topsoil and seed.
  - .11 Complete final site civil and landscaping works, including installation of new fencing.
  - .12 All other required works to construct a complete sanitary pumping station operating as intended as per the design contained in the Specifications and Contract Drawings.

## **1.2 Order of Priority**

- .1 The instructions given in this Section are to be given precedence, regarding Contract interpretation only, over the following sections within this Division.

## **1.3 Approvals**

- .1 No work can commence prior to receipt, by the Owner, of Approvals from regulatory bodies.
- .2 Refer also to Section 01060 for other approvals information.
- .3 Delays in receiving approvals shall not alter completion date.

## **1.4 Intent of Specifications**

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.4.2 of this Section at no additional cost to the Owner except as allowed at the sole discretion of the Contract Administrator.
- .4 Where a Contract item, work task, material specification, etc. is described more than once, the most stringent of the individual requirements within all descriptions shall be the standard to which the Contractor must undertake work.

## **1.5 Engineer and Contract Administrator**

- .1 In the Contract Specifications, Engineer and Contract Administrator are deemed to have the same meaning.
- .2 The Engineer is as defined in the General Conditions section of this Contract.

## **1.6 Reference to Standards**

- .1 If references to standards that appear in each Division, it is the intention of these Specifications to refer to the standard that was in effect at the time and date of the tender close for this Contract regardless of the date or version of the standard stated in the Division.

## **1.7 Loss or Damage**

- .1 The Owner shall not in any way be liable for any loss or damage by fire or other act that may happen to the work or any parts thereof, material and equipment used for construction, adjoining properties, or injuries to any person including workers and the public.
- .2 The Contractor shall properly guard against, and shall make good, all damage of whatsoever nature and origin resulting from any aspect of the Contract.

## **1.8 Provisional Items**

- .1 None.

## **1.9 Supply of Services, Material, and Equipment**

- .1 The conditions under which the required services are to be provided or material and equipment are to be installed, commissioned and their performance criterion are detailed in these Contract Documents. In submitting a bid for this project and in signing the contract for

construction with the Owner, the Contractor acknowledges these conditions. The Contractor shall be solely responsible for ensuring the performance of all services, material and equipment. The Contractor's attention is drawn to the fact that any deficiency in the supply or service agreements made by the Contractor and the terms and conditions of the Contract Documents are solely the Contractor's responsibility to rectify.

#### **1.10 Name of Project**

- .1 The project is named the "Glencoe Wastewater System Upgrades - Industrial Park Pumping Station Upgrades". "Industrial Park Pumping Station", "Industrial Park PS", "Industrial PS", "Industrial Park SPS", "Industrial Park SPS", "Industrial SPS" or other variations thereof shall be taken to mean the same as the official project name when discussing the overall Contract or Project.

#### **1.11 Sequence of Work**

- .1 Protection of Existing Structures, Services and Facilities
  - .1 Plan and carry out all construction activities in a manner to prevent damage to existing structures, services and facilities.
  - .2 Accept responsibility for and repair existing structures, services and equipment that are damaged by construction activities.
  - .3 Take all measures and provide all facilities necessary to prevent exposure of equipment to dust, fumes and excess moisture.
  - .4 Perform all construction activities in a manner to avoid creation or migration of dust, excess moisture and fumes. Provide temporary ventilation facilities where required to control dust and fumes which may damage the operation of existing equipment and controls.
  - .5 Provide additional ventilation of the area as required, in event that existing systems are inadequate.
  - .6 Isolate all activities that create dust, excess moisture and fumes by constructing suitable temporary enclosures or by some other form of protection acceptable to the Contract Administrator. Minimize to the extent possible, impact to surrounding properties.
  - .7 It is essential that dust, moisture and fumes be strictly controlled to prevent damage to equipment and to sensitive electrical instruments and control systems.
- .2 Schedule
  - .1 Submit to the Contract Administrator for approval, a Schedule of Construction in accordance with the requirements of the General Conditions.
  - .2 Submit, within 6 weeks of tender award, a commissioning plan that minimizes interruption of the pumping station operation during construction and is consistent with the Schedule for Construction.
  - .3 Without limiting the requirements of the General Conditions, the Schedule of Construction shall show detailed scheduling for all items of special nature.
  - .4 The schedule shall take into account the completion date requirements set out in Information for Tenderers pertaining to "Liquidated Damages".
  - .5 Changes in the approved Schedule of Construction shall not be made unless written permission is obtained from the Contract Administrator.
  - .6 The Contractor shall note that specific items specified have long lead times. The Contractor shall confirm these timelines following contract award. As such, the Contractor shall look to submit shop drawings for all key items as soon as possible following contract award, to mitigate any potential issues. Delay in submitting shop

drawings, including providing allowances for shop drawing resubmission requirements, shall not relieve the Contractor of their obligations for completing the work in accordance with the timelines noted.

.3 General

- .1 Careful and detailed scheduling is required to maintain operations of the existing pumping station. Some portions of the work must be completed before others can be commenced. It is the responsibility of the Contractor to submit a final commissioning plan within 6 weeks of tender award.
- .2 All work which does not interfere with operating the existing pumping station may be scheduled at any convenient time.
- .3 The construction sequence described herein is not intended to refer to each and every portion of the work. The intent is to outline the order and timing in which various phases of work should be performed to maintain facility operation and to meet the completion date requirements described in Information for Tenderers "Liquidated Damages".
- .4 Shut down of any equipment shall be carried out by the Owner at the request of the Contractor only when conditions are such that shut down of the equipment will not adversely affect facility operation or performance.

.4 Possible Sequence of Work

- .1 It remains the responsibility of the Contractor to develop and submit for approval a proposed construction schedule and sequence of work. The following describes a potential sequence that is provided only as a potential strategy for the Contractor:
  - .1 Implement environmental controls and erosion protection and otherwise prepare site for construction activities;
  - .2 Implement site access strategy;
  - .3 Construct new valve chamber complete with piping, flow meter, and valves for new pump installation.
  - .4 Install new forcemain and direct-buried air release valve and connect to forcemain stub as indicated.
  - .5 Install new generator and electrical equipment for new pumps.
- .2 Construct temporary pumping and bypass piping from inlet SPS manhole (upstream of existing wet well, located along Industrial Road) to existing valve chamber.
- .3 Commission temporary pumping and bypass system. During this time, existing pumps in existing wet well are to remain in back-up mode (power turned off during bypass testing) until temporary pumping is deemed to be operating properly.
- .4 Once temporary system is operational, plug sewer between manhole and wet well to allow for complete bypassing of the wet well for pump upgrades to proceed.
- .5 Contractor to minimize duration of temporary pumping as much as practical. Work should be undertaken once all key equipment is on site, including but not limited to commissioning of the new electrical feed and new generator, pumps, valves, etc.
- .6 Connect valve chamber to new forcemain stub as shown on the drawings.
- .7 Coordinate final tie-in work with OCWA, including switchover of forcemain at connection point. Note that the downstream switchover is to be completed through valving (no construction work is required).
- .8 Ensure final switchover is completed during low flow conditions. Work must be coordinated in advance as it will require assistance from Operations staff and potential for temporary pumping via vacuum trucks.

- .9 Remove plug and commission new pumps while temporary pumps remain present but offline. At this point, both forcemains would be in operation (existing forcemain from existing chamber, new forcemain off new chamber and new pumps).
- .10 Complete final site civil and landscaping works.

**End of Section**

## 01013 Documents

### 1.0 General

#### 1.1 Description

- .1 Define intent of drawings and specifications.

#### 1.2 Drawings and Specifications

- .1 Drawings should be reviewed with reference to complete Contract Documents and vice versa.
- .2 Drawings form part of specification and contract. Any additional work added during progress of this project to form part of specification and contract.
- .3 Specifications and accompanying drawings are apportioned more or less in accordance with general custom and practice but are not intended to rigidly define limits of the contract.
- .4 Organization of specifications into Divisions and Sections, as listed in index, is for convenience of Contractor and is not to be construed as setting up sharp divisions without overlapping or possibility that system fractions may not be specifically assigned to one or another of Sections.
- .5 Items or system fraction that has not been included in one or another of Sections of Specifications does not affect Contractor's complete responsibility for the entire job.
- .6 Work may be indicated on drawings only, in specifications only, or both on drawings and in specifications. Drawings and specifications are complementary to each other in that all apparatus, materials and equipment outlined on drawings and/or specified is to be considered essential to contract requirements regardless of their recognition or not in every instance.
- .7 Drawings show arrangement, general design and extent of piping and other systems suitably outlined regarding sizes, locations, general arrangement and installation details. Do not scale for "roughing in" measurements nor use as shop drawings.
- .8 Where any parts of system and/or items of equipment are specifically located by dimensions on drawings, check and verify said documents in field.
- .9 Should any discrepancies or interferences occur which will necessitate major revisions in work, notify the Engineer immediately. Secure authorization in writing for such revisions before proceeding with work.
- .10 Drawings and specifications are shown in metric units of measurement. Conversion between imperial and metric units of measurement shall conform to CAN/CSA-Z234.1-00 (R2011), Canadian Metric Practice Guide requirements.

#### 1.3 Specifications Explanation

- .1 Specifications are simplified abbreviated type and include incomplete sentences. "The Contractor shall", "in conformity therewith", "as noted on the drawings", "according to the plans", "a", "an", "the", and "all" are intended. Supply omitted words or phrases by inference in same manner as they are when a "note" occurs on drawings.
- .2 All reference to standard specifications or manufacturer's installation directions to mean latest edition thereof.

#### 1.4 Definition of Terms

- .1 Supply and install.
  - .1 Wherever words "supply and install" appear, it is understood that Contractor is responsible for items to which they refer, complete with all component and accessory equipment necessary for proper operation of item in best sense of preferred current practice, completely integrated into system of which it is a part, with all necessary connections to respective service systems required for full normal operation, and connections as are specifically assigned to other Contractors in specifications and/or on drawings.
  - .2 Except for such work so assigned to others, deliver all systems to Owner ready for full normal operation on "Turnkey" basis. Extras will not be allowed for component or accessory equipment items or essential operational materials or service connections necessary for full normal operation or items whether or not they appear in specifications or as shown on drawings.
- .2 Provide
  - .1 Wherever the word "provide" appears, it is understood that contractor is responsible for supplying and installing all equipment and component items which are required for successful and satisfactory operation of system or function to which term refers and perform that work in best sense of current practice. Except as otherwise defined above, applicable provisions of definition for "supply and install" to likewise govern work and responsibilities under this heading.

#### 1.5 Site Information

- .1 Dimensions and other information whether on drawings or in specifications or other documents, or given orally concerning elevations, present obstructions on or near site, locations of sewers, conduits, pipes, wires, etc., position of existing equipment, pavements, racks, etc. and nature of the structure have been obtained from sources which are believed to be reliable, but no guarantee is given for their accuracy. They are furnished solely for accommodation of Tenderer and Contractor and must be verified at time of construction.
- .2 Investigative site work is to be included in the Contractor's tender to verify the inverts and locations of existing sewers, drains and power feed concrete bus ducts to avoid interference with new work, removals or interconnections.

**End of Section**

## 01015 Contractor's Use of Premises

### 1.0 General

#### 1.1 Description

- .1 This section specifies requirements for Contractor's use of project site.

#### 1.2 General

- .1 Confine operations within areas approved by the Engineer for construction, storage and access.
- .2 At all times in which work is being performed, the Contractor shall have at least one competent and reliable superintendent in charge of the entire works, knowledgeable with respect to the Contract and authorized to make decisions on behalf of the Contractor.
- .3 Place construction offices and storage trailers, if required, at locations designated by the Owner.
- .4 Maintain access roads in good condition.
- .5 Provide every reasonable facility, co-operation and assistance as may be required by the Engineer or Inspector to carry out any inspections of the works required, and cause any Sub-Contractor to do so as well.
- .6 Maintain site in a clean and tidy condition at all times. Prevent debris from entering adjacent residential properties and street.
- .7 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) as required for all substances used or stored on site. Required MSDS/SDS sheets are to be made readily available on site at all times.
- .8 Provide storage bins for disposal of garbage and debris. These bins shall be emptied from time to time. Provide immediate removal from site of items too large to be placed in bin if one is utilized.
- .9 See also Section 01500 – Construction Facilities and Temporary Controls.

**End of Section**

## 01020 Allowances

### 1.0 General

#### 1.1 Description

- .1 Requirements for Cash Allowances.
- .2 Requirements for Contingency Allowance.

#### 1.2 General

- .1 Include in Tender Price all Cash Allowances as specified.
- .2 Cash Allowances remain in possession of Owner, Contractor is entitled only to that part of Cash Allowance used to purchase each respective material or service.
- .3 Contractor will be reimbursed difference between purchase price and Cash Allowance if purchase price of material exceeds Cash Allowance.
- .4 Unless indicated otherwise, cash allowances are for material purchase only, or for costs related to third party services to be provided, but do not include labour, overhead and profit which are to be included in Total Tender Price on Form of Tender.
- .5 The Contingency Allowance is merely for the convenience of accounting by the Owner and the Contractor is not entitled to payment thereof except for extra or additional work carried out by him in accordance with the Contract and only to the extent of such extra or additional work being authorized by the Engineer.

#### 1.3 Cash Allowances

- .1 SCADA Integration allowance, as detailed in Division 16.
- .2 Soils & Materials Testing: Compaction testing as per Section 02221, Concrete testing as per Section 03300 and any other geotechnical testing required by the Contract Administrator.
- .3 Vacuum Truck Services: This item is intended to address potential high wet weather flows that may be encountered during the contractors presence on site that is over and above the temporary pumping facilities noted. This item is not to be used by the Contractor to address issues with their staging plans or disruption of power and/or pumping capacity as a result of issues by the Contractor or sub-contractors.
- .4 Tool and Spare Pump Allowance: This item is intended to address additional equipment and provision of a spare higher-capacity pump to serve as a backup to the Glencoe WW system in the event of a primary pump failure. The pump make and model information, including an approved shop drawing will be provided to the Contractor to order the unit.

#### 1.4 Method of Payment (other)

- .1 Payment from Cash Allowances will be based on actual incurred amounts backed by invoices for work authorized by the Engineer.
- .2 The Contractor will be permitted to a mark-up of 5% on these Cash Allowances.
- .3 Unused amounts of the Cash Allowance will be credited to Owner's account. Should actual cost of materials and services covered by Cash Allowance exceed the specified amount, the Engineer will process the additional cost through a Change Order with a single mark-up of 5%.

- .4 Payments out of the Contingency Allowance will only be for additional work performed by the Contractor or his subcontractors, as approved in advance in writing by the Contract Administrator, and all in accordance with the General Conditions.

**End of Section**

## 01025 Measurement and Payment

### 1.0 General

#### 1.1 Description

- .1 General description of various measurement and payment considerations. This Section shall not limit the rights or responsibilities detailed by the General Conditions, Supplemental General Conditions, Special Provisions, nor any other laws or regulations.

#### 1.2 Related Standards

- .1 General Conditions.

#### 1.3 General

- .1 Liabilities are meant to include, but not be limited to: labour, materials and services used or reasonably required for performance of the works or any portion thereof under this Contract.
- .2 Price for work shall be full compensation for all labour, plant and materials required for complete fulfilment of the Contract.
- .3 The Engineer may, at their discretion, direct or approve that the works covered by the Contract be divided into two or more parts for the purpose of issuing Certificates of Completion and releasing holdback monies. Such division shall not limit the documentation required of the Contractor for such release.

#### 1.4 Payment

- .1 The Contractor shall submit to the Engineer, at the end of each calendar month, a fully itemized statement detailing the estimated value of work executed to the end of the month, based on the prices shown indicated in the Form of Tender, or any other such breakdown as required by the Engineer to establish payment certification, including all variations. The statement shall also include a fully itemized list of the value of major items delivered to site for incorporation into the permanent works.
- .2 The Engineer shall determine the amount payable and will prepare a Monthly Payment Certificate which will include amounts he considers to be fair, based upon the report received from the Contractor and work done to date.
- .3 For the purposes of Monthly Payment Certificates, equipment and materials delivered to site shall not be valued at higher than 80% of purchase price until completely installed, and may be valued lower at the discretion of the Engineer. Contractor shall submit copy of P.O. and/or supplier invoice showing the value of the equipment or material.
- .4 Holdback, as per the requirements of the Construction Act, shall be retained by the Owner. Maintenance Holdback shall be as per the General Conditions, Supplemental General Conditions, and Special Provisions.
- .5 No progress estimate or payment shall bind the Engineer in valuation of the work on its completion, and modifications may be made on any Monthly Payment Certificate to make correction for any previous Certificates.

## **1.5 Alterations and Extras**

- .1 No compensation for extra work or material shall be allowed unless such work or material is ordered in writing by the Engineer.
- .2 The Contractor shall report the progress and costs, in full detail, of any extra work each working day to the Engineer. The absence of such reports may invalidate any claims made for extra work.
- .3 Repair of equipment or structures damaged through the course of work under the Contract shall not be considered as extra work and will not be compensated.
- .4 The Contractor must notify the Engineer in writing of any intention to claim work done as extra prior to commencement of such work, so that a proper record of such work may be maintained. This does not necessarily indicate an acceptance of the work as extra work under the Contract.
- .5 In the absence of a written notice indicating the intention to claim work as extra, the Contractor shall forfeit his right to extra payment, and the Engineer may reject the claim as invalid.
- .6 The Contractor shall in every way assist the Engineer in establishing the costs of extra work, as requested by the Engineer.

## **1.6 Liabilities of Contractor**

- .1 The Contractor shall discharge all liabilities incurred by him by the date on which they become due.
- .2 The Contractor shall submit to the Engineer in duplicate, together with each monthly statement except the first one, a "Statutory Declaration Re: Payment of Accounts" in a form acceptable to the Engineer. Such shall be signed by an authorized signing officer of the Contractor and shall state that all workers employed by the Contractor in the performance of this Contract have been paid in full at a frequency not less than semi-monthly, up to and including the pay day immediately preceding the date of the declaration, and that all other liabilities to date have been discharged.
- .3 At any time during the progress of the Works, the Owner may, in writing, require the Contractor to submit within fifteen (15) days, by registered mail, a list of the names, addresses and amounts owing to each of the Contractor's creditors.
- .4 The Owner may withhold approval of a Monthly Payment Certificate if the Contractor fails to submit the "Statutory Declaration Re Payment of Accounts" in a form acceptable to the Owner.
- .5 No payment to which the Contractor is otherwise entitled shall be payable, at the discretion of the Engineer, so long as he or any Sub-Contractor are in default of any liabilities owing.
- .6 Upon such default, the Engineer may suspend all work under the Contract.
- .7 The Owner may, after notice in writing to the Contractor and his Surety, pay any liability of the Contractor and Sub-Contractor or make direct payment to a creditor of the Contractor or Sub-Contractor arising from this Contract. Any such monies paid by the Owner shall be deducted from any monies due or to become due to the Contractor. Should this amount exceed that still owing to the Contractor, the Contractor shall pay to the Owner the difference.
- .8 In making payments under this Section, the Owner may act upon any evidence it deems sufficient and may compromise any disputed liability.

**1.7 Liabilities of Sub-Contractors**

- .1 The Contractor shall cause every Sub-Contractor engaged under this Contract to discharge all liabilities incurred.
- .2 Workers employed by Sub-Contractors shall be paid in full no less-frequently than semi-monthly, and other charges paid by the date on which they are due.

**1.8 Correction of or Assistance with Works**

- .1 Should the Engineer determine that work is progressing too slowly, or that the results of work done are unsatisfactory, and after opportunity has been given to the Contractor to correct said deficiencies with insufficient action taken, the Owner may, at his discretion, take such steps he deems necessary to correct or expedite the Work. Any costs associated with this action shall become the responsibility of the Contractor, and the Owner may recover such costs from monies owing or to be owed to the Contractor. Should this amount exceed that still owing to the Contractor, the Contractor shall pay to the Owner the difference.

**End of Section**

## 01035 Modification Procedures

### 1.0 General

#### 1.1 Related Work

- .1 See also Section 01600 – Materials and Equipment.

#### 1.2 General

- .1 Only where products are specified with a provision for “Alternate Manufacturer”, “alternate equal”, “approved equal” or “reviewed equal”, are options or substitutions allowed. A product substitution request will only be permitted after tender close and must be completed and submitted in writing to the Contract Administrator.
- .2 The specification and designation by a trade name of any material or article or construction method or sequence, irrespective of whether qualified by the addition of the phrase “Alternate Manufacturer”, “alternate equal”, “approved equal” or “reviewed equal”, shall be used as the basis for the tender price on the specified item or task.
- .3 If the Contractor requests use of an alternate product or material, then he/she is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract. This includes any costs for the operation of the product or material over its expected lifespan.
- .4 Alternate equipment, equal or better in design, construction, performance and capacity to unit(s) specified, must be shown with a reduction in the Contract Price. Approval of alternate equipment will be subject to review of shop drawings.
- .5 If an alternative product or material is accepted for use, then the Contractor is responsible at his/her cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .6 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.
- .7 A request for product substitution or work scope modification constitutes a representation that the Contractor:
  - .1 Has investigated the proposed product/technique and determined that it meets or exceeds the quality level and performance of the specified product.
  - .2 Will provide the same warranty for the substitution as for the specified product.
  - .3 Will coordinate the installation and make changes to other Work that may be required for the Work to be completed at the Contractor’s expense and at no additional cost to the Owner.
  - .4 Waives claims for additional costs or time extension that may subsequently become apparent.
  - .5 Will reimburse the Owner for review or redesign services by either the Owner or the Contract Administrator or a duly designated third party.
  - .6 Provide cost savings to the Owner.

- .8 Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals without a separate written request.

### **1.3 Submission Procedure for Alternate Proposals of Products or Materials**

- .1 Without exception, all requests for alterations to the scope, method, materials, schedule, or any other factor potentially impacting upon the performance of the obligations under this Contract or the quality of the finished product are to be submitted in writing to the Contract Administrator no less than fourteen (14) days prior to the proposed commencement of the requested change. This shall not limit any other time requirements indicated in other Sections of this Contract.
- .2 The Contractor seeking approval of alternative equipment should submit the following information to the Contract Administrator after the Notice of Award and no less than fourteen (14) days prior to the proposed commencement of the requested change:
  - .1 Submit one (1) Adobe Acrobat format file (\*.pdf) copy (or as required by the Shop Drawing submittal form and quantity set out by the Contract Administrator) of request for substitution for consideration. Limit each request to one (1) proposed substitution;
  - .2 A description of the features present on the alternate system in comparison with the specified system;
  - .3 A description of any additional features that will be provided;
  - .4 A complete description of any changes that will be necessary to the system design including a system hydraulic analysis based on the proposed pump(s) (if applicable), (including pipe sizes, flows, velocities, retention times and number and location of recommended valves and cleanouts, if any);
  - .5 A list of exceptions to the applicable specification;
  - .6 Demonstration of compliance to Section 1.4 "Experience" of this specification;
  - .7 Procedures for use of safety features present on the alternate system and any additional safety measures that will be implemented;
  - .8 Instructions for safe operation. Equipment manufacturer's manuals addressing these issues may be used, if available;
  - .9 Shop Drawings, product data, and certified test results and other data as required attesting to the proposed product equivalence. The burden of proof is on the Contractor; and
  - .10 If the equipment differs materially or differs from the dimensions given on the drawings, the Contractor shall submit complete drawings showing elevations, dimensions, or any necessary changes to the Contract Documents for the proposed equipment and its installation. This includes the provision of sealed drawings, calculations, reports, etc. by an Engineer licensed in the Province of Ontario if this is required.
- .3 The Contract Administrator will notify the Contractor in writing of the decision to accept or reject the request.
- .4 Pre-approval, if granted, will be provided in writing by the Contract Administrator to the Contractor at least ten (10) business days following receipt of the submittal.
- .5 In the event the Contractor obtains the Contract Administrator's approval for the use of a product other than that which is shown or specified, the Contractor shall, at the Contractor's own expense and using methods approved by the Contract Administrator, make all changes

to the Work, including structures, piping, electrical, equipment and controls, that may be necessary to accommodate this product.

- .6 Acceptance of alternate proposals or equivalents shall be in accordance with the General Conditions.

#### **1.4 Experience**

- .1 The equipment furnished hereunder shall be the product of a company experienced in the design and manufacture of equipment specifically designed for use in this application. All manufacturers proposing equipment for this project shall have at least five (5) years of experience in the design and manufacture of units of identical size(s) and performance to the specified units.
- .2 Contractor (supplier) proposing alternate equipment shall also submit, as part of the submittal package, an installation list with contact person(s), phone number(s) and date(s) of installation of at least five (5) installations of the type specified herein that have been in operation for at least five (5) years in Canada (installations in the United States may be reviewed if they were utilized in similar applications as the works in this contract and for a similar climate area if climate may impact performance).
- .3 In lieu of the experience specified herein, the Contractor (supplier) of alternate equipment will be required to submit a 5-year performance bond for 100 percent of the stipulated cost of the equipment as bid and as shown in the bid schedule. This performance bond will be used to guarantee the replacement of the equipment in the event that it fails within the bond period.

**End of Section**

## 01060 Regulatory Requirements

### 1.0 General

#### 1.1 Description

- .1 Outline regulatory requirements for project.

#### 1.2 Regulatory Requirements

- .1 Codes
  - .1 It is the Contractor's responsibility to be familiar with and fully informed of all applicable bylaws, codes and regulations affecting work. Be responsible for interpretation of any changes which may affect work, without prejudice to intent of work.
  - .2 If any Federal, Provincial or local laws, codes, or ordinances impose higher standards than are required by drawings and specifications, comply with such standards and notify Contract Administrator of any changes, whether during tendering or during construction. The Contractor is responsible to ensure that his/her price tendered reflects current regulatory requirements at the time of tender close.
  - .3 Changes resulting from any of above, after tendering, will be considered as addition to or deletion from contract and reimbursement will be made accordingly.
  - .4 Additional costs arising from failure to do so to be at no additional cost to Contract.
  - .5 Should a conflict arise between this Contract Document and the applicable codes or regulations, the more stringent requirement shall apply.
- .2 Permits, Inspection and Ordinances
  - .1 All work to conform to and be executed, inspected and tested in accordance with governing codes, rules and regulations of municipality in which work is performed and also with Provincial, Federal authorities and Fire Insurance Companies having jurisdiction.
  - .2 Deliver to Owner all certificates of inspection and approval that may be required by provincial or local laws, codes or ordinances.
  - .3 Obtain and pay for all required permits for different works.
  - .4 Submit required detailed drawings to Contract Administrator for review before submitting to different authorities.
  - .5 Contract Administrator is responsible for making application and submitting all electrical drawings and specifications as required to Electrical Safety Authority (ESA) Plan Approval Department.
  - .6 Owner is responsible for the Environmental Compliance Approval (ECA) Amendment to the Ontario Ministry of Environment Conservation and Parks (MECP).
  - .7 Drawings and specifications are intended to show general design and arrangement only. Should more detailed drawings be required for

approval and installation, submit drawings to Contract Administrator for review.

- .8 Furnish to Owner and Contract Administrator, final certificates of inspection covering all phases of work, including but not limited to: Building Permitting (if applicable), ESA and TSSA inspections.

### 1.3 Abbreviations

.1	ACI	-	American Concrete Institute
.2	AISI	-	American Iron and Steel Institute
.3	ANSI	-	American National Standards Institute
.4	APWA	-	American Public Works Association
.5	ASME	-	American Society of Mechanical Engineers
.6	ASTM	-	American Society for Testing and Materials
.7	AWPA	-	American Wood Preserver's Association
.8	AWWA	-	American Water Works Association
.9	CGSB	-	Canadian Government Standards Board
.10	CSA	-	Canadian Standards Association
.11	ESA	-	Electrical Safety Authority
.12	HEPC	-	Hydro Electric Power Commission
.13	IEEE	-	Institute of Electrical and Electronics Engineers
.14	MECP	-	Ontario Ministry of Environment, Conservation and Parks
.15	OPSS	-	Ontario Provincial Standard Specifications
.16	OPSD	-	Ontario Provincial Standard Drawings
.17	CISC	-	Canadian Institute of Steel Construction
.18	NBC	-	National Building Code of Canada
.19	OBC	-	Ontario Building Code Act
.20	NFPA	-	National Fire Protection Association
.21	TSSA	-	Technical Standards and Safety Authority

**End of Section**

## 01080 Identification Systems

### 1.0 General

#### 1.1 General

- .1 Section covers requirements for installation of Equipment and Component identification tags. Information contained in this section is provided as a courtesy for the general information of the Contractor and is not intended to be complete in any way.
- .2 The installation of equipment identification tags does not relieve the Contractor/manufacturer of the responsibility to ensure proper nameplates are affixed to all equipment provided.

#### 1.2 Additional Requirements Specified Elsewhere

- .1 Division 11 Equipment
- .2 Division 16 Electrical

### 2.0 Products

#### 2.1 Material

- .1 Each nameplate shall be complete with bevelled edges and engraved wording to completely identify the equipment with no abbreviations except where approved within this document.
- .2 Nameplates shall be laminated 2-ply coloured plastic plates, which are a minimum of 1.6mm thick and shall be engraved using Micarta lettering.

#### 2.2 Colours

- .1 Text – Black.
- .2 Background – White.

#### 2.3 Content

- .1 Wording is generally to be as per the drawings or IO point listing but must be reviewed prior to engraving by the Engineer. Submittal must show text, placement of text & size of text.
- .2 The following table provides size guidelines. Actual sizes shall be as instructed by the engineer following submission of text for nameplates.

No.	Dimensions (mm x mm)	Letter Height (mm)	Location
1	10 x 25	6	Control Labeling (e.g. "Off")
2	25 x 75	8, 10	Instrumentation & control equipment
3	20 x 100	8	Control panels & terminal cabinets
4	35 x 200	20	Control room
5	35 x 200	20	Wet Well Access
6	35 x 200	20	Wet Well
7	40 x 40	8	Valve Tags

- .3 All devices shall be tagged at the location of the device.

### **3.0 Execution**

#### **3.1 Installation – General**

- .1 The following general guidelines shall be followed for all equipment.
  - .1 Mount all specified identification indicators in clear view and positioned such that the text can be easily read without need for the individual to stoop, bend or stretch.
  - .2 Do not obstruct visibility by wire bundles or other equipment.
  - .3 All identification nameplates are to be applied prior to installation.
  - .4 Where works completed under this project interfaces with existing equipment (e.g. reuses or supplements) and field devices, all existing identification shall be replaced with identification conforming to these standards where the coding used is out of compliance.
  - .5 Generally, nameplates shall be attached by epoxy glue directly to devices. Before application, surfaces shall be properly cleaned and prepared to ensure secure and permanent attachment.
  - .6 Where not practical to device mount, securely fasten to each device or to a conduit clamp located near the device with 16-gauge stainless steel straps.

**End of Section**

## 01200 Project Meetings

### 1.0 General

#### 1.1 Description

- .1 Outlines requirements for project meetings.

#### 1.2 General

- .1 Attend all project meetings scheduled by Contract Administrator.

#### 1.3 Pre-Construction Meeting

- .1 The Contractor undertaking the pumping station work shall be present at the project Pre-Construction Meeting.
- .2 Contract Administrator will provide an agenda with meeting request.
- .3 Location: To be determined by Contract Administrator.
- .4 Attendance:
  - .1 Owner's representative,
  - .2 Contract Administrator and/or Site Inspector,
  - .3 Contractor's Project Manager and Supervisor,
  - .4 Others as appropriate, as determined by the Contract Administrator.
- .5 Purpose of Meeting:
  - .1 Identify and introduce personnel participants in Work.
  - .2 To discuss site requirements (temporary facilities, signage, storage, security, etc.).
  - .3 To discuss communication requirements between parties.
  - .4 To discuss contract procedures and processing of field discussions, submittals, change orders and applications for payment.
  - .5 To discuss the Work schedule, including Products delivery.
  - .6 To discuss schedule for submission of shop drawings, samples and other submissions.
  - .7 To discuss any other matters that may have arisen.
  - .8 To plan or conduct a preconstruction walkthrough.
- .6 Contractor to prepare in advance and to submit at this meeting a reasonably accurate monthly project expense forecast and schedule.

#### 1.4 Pre-Construction Walkthrough

- .1 A pre-construction walkthrough of the site shall be completed prior to commencing work on the site.
- .2 The purpose of the walkthrough is to familiarize the Contractor with the site and to identify any potential problems and risks associated with the work to be undertaken.
- .3 Attendance:
  - .1 Contract Administrator and/or Site Inspector,

- .2 Contractor's Project Manager and Supervisor,
- .3 Others as appropriate, as determined by the Contract Administrator.
- .4 The walkthrough can form a part of the pre-construction meeting or can be scheduled at a different time.

### **1.5 Progress Meetings**

- .1 To be held on a bi-weekly basis during construction or as indicated by the Contract Administrator.
- .2 Location of Meeting: To be designated at time of construction by the Contract Administrator.
- .3 Attendance:
  - .1 Contract Administrator and/or Site Inspector,
  - .2 Contractor's Project Manager and Supervisor,
  - .3 Owner as required,
  - .4 Others as appropriate, as determined by the Contract Administrator.
- .4 Agenda to include following:
  - .1 Review, approval of minutes of previous meeting.
  - .2 Review of work progress since previous meeting.
  - .3 Field observations, problems, conflicts.
  - .4 Problems which impede construction schedule.
  - .5 Review of off-site fabrication delivery schedules.
  - .6 Corrective measures and procedures to regain projected schedule.
  - .7 Revision to construction schedule.
  - .8 Progress schedule, during succeeding work period.
  - .9 Review submittal schedules.
  - .10 Maintenance of quality standards.
  - .11 Review proposed changes for effect on construction schedule and on completion date.
  - .12 Review site safety and security issues.
  - .13 Other business.
- .5 Representatives of Contractor attending meeting should be thoroughly informed and knowledgeable with respect to proposed topics of discussion and authorized to act and make commitments with respect to matters agreed to at the meetings.
- .6 Contract Administrator to chair meeting, record and distribute Minutes of Meeting.

**End of Section**

## 01210 Pre-Start Health and Safety Report

### 1.0 General

#### 1.1 Description

- .1 It is the Contractor's responsibility to submit a pre-start health and safety report before commencement of any field work.
- .2 Under this contract, the Contractor is to assume the role "Constructor" as it is defined in the Occupational Health & Safety Act.

#### 1.2 Related Work

- |    |               |   |
|----|---------------|---|
| .1 | Section 01650 | Safety Review, Equipment Commissioning and Training |
| .2 | Section 01680 | Physical Checkout: Shop and Field Testing           |
| .3 | Section 01730 | Operation and Maintenance Manuals                   |
| .4 | Section 01780 | Closeout Submittals                                 |

#### 1.3 Pre-Start Health and Safety Review

- .1 A Pre-Start Health and Safety Review (PSHR) must be undertaken prior to handover of the complete facility.
- .2 The PSHR is to be prepared for the required elements of the facility, including equipment, and submitted for review. This includes a review of the equipment before and after shop drawing submission and approval.
- .3 The PSHR summarizes the results of the PSHR and outlines all actions that will be/have been taken in accordance with the Industrial Ontario Regulations for Industrial Establishments, Ontario Regulation 851 Section 7.
- .4 Contractor is responsible to ensure all equipment supplied and installed meets the hazardous area classification as identified in the Contract Drawings.
- .5 Any and all additional signs and labels beyond what is provided in the Contract Documents and recommended by the PSHR engineer shall be submitted to the Contract Administrator for approval. Supply and install costs for any additional signs and labels shall be the responsibility of the Contractor.
- .6 The PSHR is to be prepared for the complete facility, including equipment, and submitted for review.
- .7 The PSHR is to be prepared and sealed by a Professional Engineer registered to practice in the Province of Ontario.
- .8 Substantial Completion will not be granted until a final approved Report is received in good order by the Contract Administrator.

**End of Section**

## 01300 Submittals

### 1.0 General

#### 1.1 Description

- .1 Outlines requirements for submission of shop drawings, product data and samples. Unless otherwise noted, submittals are to be made to the Contract Administrator.
- .2 Note the requirement for electronic submittals to the Contract Administrator. Paper copies will not be accepted unless explicitly stated in the Specifications.
- .3 The General Contractor shall submit shop drawings via email (email address to be provided at pre-construction meeting). Returned shop drawings shall also be returned via email.
- .4 For products proposed as alternates to approved products or manufacturers, refer also to Section 01035.

#### 1.2 Shop Drawings

- .1 Provide one (1) Adobe Acrobat format file (\*.pdf) not including hard copies required as per Section 01730 of drawings, data sheets, etc.
- .2 Identify each shop drawing with a cover sheet, giving reference such as:
  - .1 Project name and location,
  - .2 Section of specifications where specified,
  - .3 Location where equipment or material is to be installed,
  - .4 Name of Sub-Contractor or supplier,
  - .5 NFPA 820 Area Classification, and
  - .6 Other relevant information.
- .3 Each shop drawing submitted by the Contractor shall have affixed to it the following certification statement and shall be signed by the Contractor: "Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalogue numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements."
- .4 Shop drawings will not be reviewed by Contract Administrator unless they have been signed and stamped (as per above), certifying review and approval of submittal by the Contractor.
- .5 Shop drawings to detail completely equipment to be installed and components thereof, including the location and type of process connections and mounting hardware.
- .6 Submit attached Shop Drawing Review Checklist with each submittal.
- .7 All dimensions must be shown in metric units.
- .8 The Contractor shall fill in all missing dimensions and data on shop drawings prior to submitting for review.
- .9 The Contract Administrator is not responsible for dimensional check and missing information on the shop drawing submission.
- .10 The Contractor shall provide an itemized list of all shop drawings to be submitted with approximate dates for submittal.

- .11 The Contractor shall utilize a 10-character (or 11-character) submittal identification numbering system in the following manner:
- .1 The first character shall be a D, S, P, M or R, which represents Shop/Working Drawing and other Product Data (D), Sample (S), Preliminary Submittal (P), Operating/Maintenance Manual (M), or Request for Information (R).
  - .2 The next five (or six) digits shall be the applicable specification section number.
  - .3 The next three digits shall be the numbers 001-999 to sequentially number each initial separate item or drawing submitted under each specific section number.
  - .4 The last character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawings, ie. A=first submission, B=second submission etc. A typical submittal number would be as follows:  

D-03300-008-B

D	=	Shop Drawing
03300	=	Specification Section for Concrete
008	=	The eighth initial submittal under this specification section
B	=	The second submission (first resubmission) of that particular shop drawing
- .12 Notify the Engineer, in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.
- .13 In the absence of a request for a variance, it will be assumed that the submittal is not a substitute and meets all the Contract Document requirements.

### 1.3 Certified Outlines and Descriptive Literature

- .1 Provide one (1) Adobe Acrobat format file (\*.pdf) (not including hard copies required as per Section 01730) of manufacturer's certified outlines and descriptive literature to Contract Administrator for review.
- .2 Describe fully all materials and equipment to be used on project.
- .3 Detail off-loading and storage requirements.
- .4 Detail recommended installation requirements.
- .5 Publication to be current at time of invitation to Tender.
- .6 Motor shop drawings or literature to include performance data and characteristic curves.
- .7 Identify Manufacturer's recommended spare parts and supply at time of commissioning.
- .8 Identify any special tools required to operate, maintain or repair equipment and supply at time of commissioning.
- .9 All products that include a control panel as part of the scope of supply shall include in the shop drawing submittal a process narrative describing the functionality of the equipment, along with electrical and controls schematics for the equipment package and control panel.
- .10 Refer to Items 1.2.3 and 1.2.4 above for processing before submittal.

### 1.4 Equipment with Electrical or Electric Components

- .1 Shop drawings of equipment furnished with electrical controls or devices are to include electrical wiring diagrams with Bill of Material showing manufacturer's catalogue numbers and other rating data required for all relays, timers, starters and other components.

- .2 Electric circuit diagrams to show complete electrical ratings for all electronic components adjacent to components in diagram, as well as universal generic and manufacturer's parts numbers.

### **1.5 Test Reports and Certificates**

- .1 For all pumps supplied, submit certified, non-witness characteristic curves from the Manufacturer indicating relationship between speed, capacity, head, power, NPSH and efficiency. Indicate design operating point on curve.
- .2 For motors supplied, even when supplied as part of a larger unit, submit dimensional drawings of motor and operational details including full output power (kW), rpm and slip.

### **1.6 Revision of Shop Drawings**

- .1 Submittals that are not fully identified as instructed in this specification shall be returned without review. The Engineer will be reimbursed by the Owner for all subsequent reviews and the Owner will deduct the amount of the reimbursement from the Contractor's contract. The Engineer's reimbursement shall be on a time and expense basis at the current billing rate of the Engineer. The Engineer shall be the sole source for determining the suitability of any submittal.
- .2 Make any corrections or changes required by Contract Administrator and re-submit one (1) electronic copy of revised drawings as per above.
- .3 The Engineer has allowed for up to and including two (2) reviews total of each submission (i.e. only one (1) revision and resubmission will be accepted by the Contract Administrator without penalty). The Engineer shall be reimbursed for all reviews after the first two reviews by the Owner and the Owner will deduct the amount of the reimbursement from the Contractor's contract. The Engineer's reimbursement shall be on a time and expense basis at the current billing rate of the Engineer. The Engineer shall be the sole source for determining the suitability of any submittal.
- .4 Do not make any changes to shop drawings after final review without written permission of Contract Administrator.
- .5 Do not proceed with Work affected by submittals until review is complete.

### **1.7 Contract Administrator's Review**

- .1 Review of shop drawings by Contract Administrator to be construed as gratuitous service to Contractor. Acceptance of contract implies unequivocal responsibility by the Contractor for all equipment specified and furnished under contract.
- .2 It is understood that shop drawings are not considered reviewed, and the items covered are considered rejected (even after installation) if, after review, it develops that:
  - .1 Items fall short of complete equality with items as specified in judgement of Contract Administrator with respect to areas not fully covered on shop drawings (nature, suitability and quality of component materials, thickness of materials, finishes, sturdiness of construction, performance in terms of generally accepted standards, completeness of accessory features and equipment, workmanship, quality levels, or any other criteria as determined by the Contract Administrator).
  - .2 Notwithstanding any equipment or materials having been reviewed, if at any time any equipment or materials used on work purporting to be equivalent to those submitted do not meet standards of specification, then the Contract Administrator may have such material or equipment removed from site and replaced by approved material at no extra cost.

- .3 The Contractor should allow for ten (10) working days between submittal of a shop drawing and receipt of review comments (if any). If subsequent submissions are required, the same review period of 10 working days applies.
- .4 In the event that the Contractor does not receive a response within ten (10) working days, notify the Contract Administrator in the event of issues related to receipt of the drawings. The Contract Administrator and Contractor shall work cooperatively to resolve issues.

## **1.8 Timely Submission**

- .1 Submittals are to be made with reasonable promptness and in accordance with the approved Work and submission schedules. Failure to submit in ample time shall not be considered cause for any extension of Contract Time.

**End of Section**



## 01420 Inspections

### 1.0 General

#### 1.1 Description

- .1 The following is a general, but not necessarily complete description of the role of the Contract Administrator or designees as Inspector.

#### 1.2 Inspector and Inspection

- .1 The Inspector shall be the Contract Administrator or an agent or third party authorized to act for the Contract Administrator.
- .2 The Inspector ensures the provisions of the Contract, including quality of workmanship and materials.
- .3 The Inspector has the authority to order changes to work methods or sequence, or to stop work entirely. The Contractor must obey such orders immediately, at no cost or claim to the Contract.
- .4 The Inspector has the authority to suspend any worker for incompetence, drunkenness, negligence or disregard of orders, and the Contractor shall ensure their removal from the site.
- .5 The Inspector shall give the Contractor reasonable notice of materials or equipment intended to be inspected or tested, save those areas already designated in the Contract as requiring inspection. The Contractor shall notify the Contract Administrator in writing at least seven (7) days in advance of commencing preparation or manufacture of items to be inspected in order that the Inspector may be present.
- .6 If additional inspections are required by law, local by-law or regulations, the Contractor shall arrange for such inspections and give the Contract Administrator reasonable notice of the time and date proposed for such additional inspections.
- .7 Should a part of the works requiring inspection be covered, the Contract Administrator may cause the Contractor to make such tests, openings, excavations etc. as required to perform the inspection. If the work is found to be imperfect in the opinion of the Contract Administrator, the costs of such tests, openings, excavations etc. shall be borne by the Contractor. If the work is acceptable, the Owner shall bear the costs of such undertakings.
- .8 No inspection of, or failure to inspect, any part of the works, materials or equipment on the part of the Contract Administrator/Inspector shall relieve the Contractor of his responsibility to provide finished works of a high quality.

**End of Section**

## 01500 Construction Facilities and Temporary Controls

### 1.0 General

#### 1.1 Description

- .1 Requirements for provision of construction facilities and temporary controls.

#### 1.2 General

- .1 Furnish, install and maintain temporary facilities required for construction or works.
- .2 Remove temporary facilities upon completion of contract.
- .3 Be responsible for the protection of the natural environment of the site and surrounding areas, both land and water, for the duration of the Contract.
- .4 Refer also to Section 01585 for other requirements.

#### 1.3 Construction Equipment

- .1 Provide proper equipment suitable for work.
- .2 Provide for standby equipment as necessary.
- .3 Maintain all equipment in proper working order and in operation as required.
- .4 Provide efficient equipment maintenance to minimize exhaust emissions.
- .5 Store all equipment in an orderly manner and in a location acceptable to the Contract Administrator.
- .6 Equipment maintenance and fuelling to be done so that oil and fuel does not gain access to surface water or groundwater.
- .7 No machinery required for the performance of any aspect of the Contract, which has been brought onto the job site, shall be removed from the job site without the written approval of the Contract Administrator.
- .8 Ensure equipment is clean and free of plant material prior to entering and leaving the site to prevent transfer of invasive plant species.

#### 1.4 Temporary Buildings

- .1 Provide temporary buildings for staff and construction purposes, at location(s) approved by Owner or Contract Administrator.
- .2 Keep temporary buildings free and clear from nuisance.
- .3 Make all arrangements for occupying adjacent properties and pay for all expenses.
- .4 Provide adequate fire extinguishers at all temporary buildings.
- .5 Comply with requirements of any local, provincial or national legislation pertaining thereto.
- .6 Pay all permits and fees in connection with erection, movement or placing of any temporary buildings.

## **1.5 Temporary Utilities**

- .1 Provide all temporary telephone, high speed internet service, power and light required during construction.
- .2 Make all necessary applications, obtain permits and pay all charges to service and use.

## **1.6 Site Storage**

- .1 Provide and maintain outside storage facilities in a location approved by the Contract Administrator. Provide enclosed storage space for Products that cannot be stored unprotected.

## **1.7 Piles and Excavations**

- .1 Provide fencing for all open excavations deeper than 0.6 m at all times except to allow access for construction activity. Fencing shall be 1.5 m high and secured to "T" posts at intervals not exceeding 2.5 m. Fencing shall be "utility type wire fence" or "reinforced snow type fence" and shall provide a secure area.
- .2 Stockpiles of backfill material are to be placed within the boundary of the fenced area and are to be a maximum of 1 m in height, sited so as not to interfere with site drainage, access or other construction work. Stockpiles shall be level, well drained and away from on-going excavation to prevent foreign material from entering the pile.
- .3 Prevent movement, settlement or damage of adjacent structures, services, sidewalks, paving, trees, landscaping and adjacent grades. Bracing, shoring and underpinning shall be provided as required.
- .4 Ensure that the work site is left in a safe condition so that no part of the structure being built is in danger of falling, open excavations are fenced, and all materials are safe from pilfering. Equipment, vehicles and stockpiled materials that are stored on site during non-working periods shall be within the fenced area of construction and left in tamper resistant condition.
- .5 Conduct a daily clean-up of the site at the end of each working day. Ensure that any debris is placed at a site acceptable to the Contract Administrator or removed from the site.
- .6 Provide forces within two (2) hours of notification by the Owner or Contract Administrator to address any safety or site clean-up issue at any time during which work is not being undertaken on the job site.

## **1.8 Protection of Work**

- .1 Provide temporary enclosures, coverings, etc. for protection of work and to facilitate plant operations until completely protected from elements by building construction.
- .2 Provide all other protection required to properly safeguard Owner's property and equipment, employees and public.
- .3 Provide, erect and maintain all necessary guardrails, barriers, signage, lights and other protection around excavations and building sites to comply with ordinances and bylaws of municipality.
- .4 Owner shall not be responsible for any damage or expenses arising from failure to comply with municipal by-laws or ordinances.
- .5 Provide all temporary hoists, ladders, railings, safety equipment, etc. and maintain as required by Construction Hoists Act and Occupational and Safety Act and Regulations for Construction Projects.
- .6 Pumping station security to be maintained for the duration of the Contract.

### **1.9 Weather Protection**

- .1 Provide temporary or permanent enclosure of work or portions thereof as required to prevent damage by rain, wind or cold weather.
- .2 Be responsible for any damage to work due to failure to provide adequate heating or other protection, and make good such damage to satisfaction of Contract Administrator.

### **1.10 Fire Protection**

- .1 Provide and maintain adequate fire extinguishers for protection of work during construction period; locations on site to meet requirements of insurance company.
- .2 Provide all other temporary fire fighting equipment as required by local fire department, insurance authorities and Ontario Building Code at no extra cost to Owner.
- .3 No fires are permitted anywhere on site for disposal of rubbish and surplus materials.
- .4 Bulk storage of flammable liquids and other hazardous materials will not be allowed within any building at any time during construction period. Handle all inflammable liquids only in approved containers.
- .5 Store and mix paint materials only in approved locations and take all precautions against fire hazard. Place all oily waste and rags after use in approved safety containers and remove from building at end of each working day.

### **1.11 Water Control**

- .1 Direct pump storm water or run-off to settling ponds or sediment basins prior to discharge to adjacent storm sewers or watercourses.
- .2 Provide settling ponds and sediment basins where needed.
- .3 Control overflow rates from settling ponds or sediment basins to ensure minimum solids transportation.
- .4 Provide straw bales, filter berms or sand bags as required to retard and filter run-off prior to discharge to storm sewers or watercourses.
- .5 Intercept and divert concentrated run-off from un-stabilized areas under sheet flow conditions.
- .6 Do not direct any flow of water across or over pavements, except through approved pipes or properly constructed troughs.
- .7 Keep gutters open at all times for surface drainage.
- .8 Provide splash pads where water is discharged to watercourse.
- .9 Dispose of water so as not to be injurious to public health and safety, to property or to any part of work completed or under construction.

### **1.12 Construction Laydown, Parking, Access and Work Areas**

- .1 Laydown areas will need to be approved by the Contract Administrator. Materials and equipment storage, parking and site office facilities will be restricted to the area developed as a laydown area.
- .2 The Contractor shall prepare, develop and maintain laydown, parking access, work and staging areas as required to execute the Work. There shall be no clearing or cutting of trees or shrubs except as allowed by the Contract Administrator. There shall be no stripping of existing surficial soils and materials on site except as required for the provision of an excess concrete/truck mixer washings disposal basin.

- .3 The Contractor shall be responsible for the security of all work and access areas adjoining areas open to the public and shall at all times prevent public access to the Work.
- .4 The security of the property of the Contractor on site shall be entirely the responsibility of the Contractor. Installation of temporary security facilities shall be at the discretion of the Contractor and such facilities shall be removed on completion of the Work.
- .5 Laydown, parking, work and access areas shall be cleaned of all construction materials and debris and shall be restored by the Contractor upon completion.

#### **1.13 Liquid Storage, Refueling and Equipment Operation**

- .1 Small containers of fuel and other chemical products shall have secure secondary containment and shall be protected at all times from accidental spillage.
- .2 Sorbent materials shall be on hand at all liquid storage areas, whether for large or small volumes, as a means of containing or soaking up errant spills.
- .3 All Equipment shall be in good condition and meet applicable statutory requirements for serviceability and exhaust emissions. Exhaust systems shall function in a manner to control exhaust noise within acceptable regulated levels.
- .4 Major repairs to equipment will not be permitted at the work site.
- .5 The Contractor shall be responsible for any and all clean-up of contamination resulting from its operations.
- .6 Contaminated granular materials and other contaminated soils shall be carefully excavated and shall be disposed of according to MECP regulations and guidelines. These materials may be classified as hazardous waste.
- .7 Soils and similar materials contaminated by equipment operating fluids shall be removed from site and disposed of in accordance with this specification and all applicable regulations.

#### **1.14 Construction Noise Control**

- .1 Construction safety (OHSA requirements) and local municipal bylaws shall provide the regulatory basis for noise control and hearing protection. Noise bylaws shall be used in setting hours of work limitations.

#### **1.15 Dewatering**

- .1 In accordance with Section 02140 – Dewatering and Site Drainage.
- .2 It is anticipated that the Contractor will dewater the work areas for the construction of tankage, and structural footings, walls and slabs. The Contractor shall provide dewatering and seepage control measures sufficient to allow for the placement of the works in accordance with the approved design drawings. The Contractor shall have a dewatering plan and this plan shall meet with the concurrence of the Contract Administrator.
- .3 The Contractor will provide all required monitoring and recording to confirm the rate and total amount of dewatering and will at no time be allowed to exceed 400,000 litres per day without a Permit to Take Water for the project. If monitoring and recording is not being carried out, dewatering activities should cease immediately.
- .4 Work area runoff including seepage water shall be directed to settling/filtering facilities located on land to meet the water quality protection requirements in accordance with this specification and all applicable regulations.
- .5 Work runoff water contaminated with hazardous substances shall be treated as the product of a spill to the environment.

- .6 Where geotextiles, filter fabrics and plastic geomembranes are used they shall be removed in their entirety on completion and, if uncontaminated, shall be disposed off site as construction garbage. Contaminated geotextiles and geomembranes shall be disposed off site in accordance with this specification and all applicable regulations.
- .7 Other waste grout components and set grout shall be disposed of in accordance with this specification and all applicable regulations.

**1.16 Overloading**

- .1 Do not load any part of structure during construction with load greater than intended to bear safely when completed.
- .2 Every temporary support to be as strong as permanent support.
- .3 Do not place any material load on reinforced concrete floors until permanent set has been obtained.

**1.17 Contract Administrator's Site Office**

- .1 A site trailer is not required for this project.

**End of Section**

## 01545 Safety Requirements

### 1.0 General

#### 1.1 Construction Safety Measures

- .1 Observe and enforce construction safety measures of National Building Code, latest edition, Part 8, Provincial Government, Workplace Safety & Insurance Board, municipal statutes and WHMIS.
- .2 In the event of conflict between any provisions of above authorities, the most stringent provision governs.

#### 1.2 Safety

- .1 General
  - .1 Conform to the regulations of the Occupational Health & Safety Act.
  - .2 If, at any time, the Contract Administrator or Inspector considers the works to be unsafe, he/she may order the Contractor to remedy the situation. Should the Contractor fail to take adequate measures, the Contract Administrator may order the work to cease until such measures have been taken. Such delay shall not be cause for an extension of Contract time, nor for additional compensation.
  - .3 Prior to visiting or working on the construction site, it is necessary for all personnel to complete the Municipality of Southwest Middlesex safety policy orientation.
- .2 Contractor as Constructor
  - .1 Under this contract, the Contractor is to assume the role “Constructor” as it is defined in the Occupational Health & Safety Act.

#### 1.3 Fire Safety Requirements

- .1 Comply with requirements of FCC No. 301-1982 Standard for Construction Operations, latest edition, issued by Fire Commissioner of Canada (FC).
- .2 Comply with requirements of the National Fire Code of Canada (NFC), 2020, latest edition, issued by the National Research Council of Canada as it relates to construction activities and operations.

#### 1.4 Overloading

- .1 Ensure no part of Work is subjected to a load that will endanger its safety or will cause permanent deformation.

#### 1.5 Falsework

- .1 Design and construct falsework in accordance with CSA S269.1-1975, latest edition.
- .2 All falsework design shall be certified by a Professional Engineer licensed to practice in the Province of Ontario.

#### 1.6 Materials on Site

- .1 Comply with WHMIS requirements regarding all materials stored on site. Submit safety data sheets for Contract Administrator prior to shipping materials.

## **1.7 Lock-Out/Tag-Out Procedure**

- .1 The Contractor and their employees and Sub-Contractors shall employ and strictly follow the Owner's Lock-out/Tag-out procedure at all times.
- .2 It is the workers' responsibility to ensure that it is safe to proceed with work. The presence of an Owner's lock or tag shall not relieve the worker of this responsibility, and the worker shall not rely on such as an indication of safe work conditions.
- .3 The Owner's Lockout/Tagout procedure will be provided at the pre-construction meeting.

## **1.8 Hot Work/Live Work Procedures**

- .1 The Project may require hot work/live work. As a part of this project, the Contractor shall submit its company policies and procedures for hot work/live work. This submission shall be required at the pre-construction meeting.

## **1.9 Confined Space Entry**

- .1 The Project may require confined space entry. As a part of this project, the Contractor shall submit its company policies and procedures for confined space entry. This submission shall be required at the pre-construction meeting. Policies to be in conformance to all current Regulations and Codes.
- .2 The following procedures will apply to all confined spaces and/or areas where a potential hazard could exist.
- .3 The Contractor and his employees and Sub-Contractors shall abide by the Owner's policy for confined space entry unless their company policies are more stringent, as determined by the Contract Administrator.
- .4 In a confined space in which there is likely to exist hazardous gas, vapour, dust, fumes or oxygen deficiency, the worker must first test and record the atmosphere conditions in the confined space, wear breathing apparatus and safety harness when entering, and monitor atmosphere at all times while working in the confined space.
- .5 At no time will an employee enter a confined space where a hazardous condition exists without first notifying the supervisor and following the adopted procedure.
- .6 Do not enter confined space areas where the safety equipment supplied is not suitable or available.
- .7 All confined space entries must be done to meet the current Occupational Health and Safety Act requirements.

**End of Section**

## 01585 Site Environmental Management

### 1.0 General

#### 1.1 Description

- .1 Requirements for site environmental protection and management.

#### 1.2 Environmental Protection and Related Measures

- .1 No separate payment will be made for the provision of all labour, materials, pumping station, and equipment to comply with the environmental protection requirements of this Section of the Specifications and all distinct clauses contained within it. Full compensation for complying with all the requirements of this Section shall be deemed to be included in the payments for the Work to which these requirements are related.

- .2 Environmental Requirements

- .1 General

- .1 This section of the Specification provides the technical requirements for environmental protection under the Contract.

- .2 Compliance

- .1 The Contractor and each subcontractor, while performing the Work, shall comply with relevant statutes, regulations, bylaws and directives of legislative authorities in all matters relating to the protection of the environment. Without limiting the generality of the foregoing, the following legislation is called to the attention of the Contractor.

- .2 Federal

- .1 Canadian Environmental Protection Act
      - .2 Canada Wildlife Act
      - .3 Fisheries Act
      - .4 Navigable Waters Protection Act
      - .5 Hazardous Products Act
      - .6 Transportation of Dangerous Goods Act
      - .7 Explosives Act.

- .3 Ontario

- .1 Safe Drinking Water Act
      - .2 Environmental Protection Act
      - .3 Ontario Water Resources Act
      - .4 Occupational Health and Safety Act
      - .5 Aggregate Resources Act
      - .6 Ontario Heritage Act
      - .7 Pesticide Act
      - .8 Lakes and Rivers Improvement Act
      - .9 Wilderness Areas Act
      - .10 Forest Fires Prevention Act
      - .11 Gasoline Handling Act

- .12 Highway Traffic Act.
- .4 Local
  - .1 Local Municipal Bylaws e.g., noise control, licensing of trades people
- .3 Conditions of Approval
  - .1 All permits, authorizations and approvals obtained by the Owner and pertinent to this Contract will be made available to the Contractor by the Contract Administrator at the start of Construction.
  - .2 The Contractor shall fully comply with all conditions of such permits, authorizations and approvals.
- .4 Conflicts and Omissions
  - .1 If the Contractor finds or observes that there appears to be a conflict between the contents of this Section or other sections of the Contract Documents and the requirements of legislative authorities, then the most stringent requirement is deemed to apply. The Contractor shall bring any conflicts to the attention of the Contract Administrator for clarification. Similarly, any omissions shall in no way diminish the Contractor's responsibility to comply with the statutes, regulations, bylaws and directives of legislative authorities.
- .5 Environmental Site Awareness
  - .1 The Contractor will be required to attend a pre-construction meeting with the Contract Administrator to review site specific regulatory and environmental management requirements for this contract.
  - .2 The Contractor shall maintain an awareness of environmental requirements and developing issues on site. The Contractor's Environmental Coordinator in consultation with the Contract Administrator shall hold formal environmental orientation meetings involving key site personnel. The Contractor shall have an environmental component at its weekly work-group toolbox meetings involving all workers. Orientation meetings with members of the site team shall be held at the start of the Work (at the time of mobilization) and when new staff joins the workforce. Environmental review meetings with the site team shall also be held at other key times throughout the Work prior to starting significant new tasks. The Contractor shall review the environmental content of its orientation, as well as review and toolbox meetings with the Contract Administrator.
  - .3 The Contractor shall provide minutes of its orientation, review and toolbox meetings to all attendees and the Contract Administrator. Each attendee shall be required to sign an attendance list which includes a point form summary of the meeting content.
- .6 Hazardous Substances
  - .1 The Contractor shall make itself fully aware of all Federal and Provincial legislation and restrictions on the storage and use of certain products or materials considered harmful to the environment or persons and shall comply with all applicable regulations and guidelines. The Contractor shall require its manufacturers and/or suppliers to provide current Material Safety Data Sheets/Safety Data Sheets (MSDS/SDS) for all such products and shall comply with all requirements of the Workplace Hazardous Materials Information System (WHMIS) Regulations. The Contractor shall promptly provide the Contract Administrator with copies

- of all MSDS/SDS relating to all hazardous substances brought to the project site.
- .7 Water Management
- .1 The Contractor shall make itself fully aware of groundwater levels and water levels in creeks and channels, water flow and weather conditions in and affecting the Work and shall allow for all effects that any such conditions might have on the Work.
- .8 Waste Management
- .1 The Contractor shall dispose of all wastes generated on site and shall be responsible for all permits and approvals required for waste disposal. For recycled materials and for disposal of hazardous, subject and contaminated wastes, the Contractor shall provide proof of recycling and/or disposal documentation to the Contract Administrator.
- .2 The Contractor shall provide information on quantities of principal products brought to site and quantities of like products reused, recycled and wasted in the process of using these products. The Contractor shall also provide information on quantities of wastes arising from demolition and concrete removals and corresponding quantities reused, recycled and wasted.
- .3 Waste types anticipated at the work site include sanitary sewage, domestic garbage, construction garbage, concrete and cement grout wastes, iron and steel wastes, granular materials wastes, small electrical fixtures, ware, formwork and false work wastes, operating fluid wastes from vehicles and construction equipment and collected sediment. Disposal of these and other wastes shall be as indicated in this Section. The Contractor shall recycle wastes where possible.
- .4 Sanitary sewage shall be collected in portable toilet facilities. Waste shall be disposed of at a licensed disposal location by a licensed hauler. Waste shall be removed on a regular basis consistent with health and safety requirements.
- .5 The Contractor shall minimize the volumes of domestic and construction garbage produced on site. An MECP-approved local landfill shall be used for disposal of domestic and construction garbage. Waste storage bins with lids shall be provided by the Contractor and used on site for collection and temporary storage of domestic garbage. The Contractor shall ensure that wastes are deposited in designated bins and that the site is kept in a clean and tidy condition. Waste shall be removed on a regular basis to avoid accumulation on site. All electrical fixtures, wiring and other waste types, impractical to recycle due to the anticipated small volume will be treated as construction garbage.
- .6 All excess wet concrete, excess cement grout truck mixer washings shall be disposed of in a washout basin to be developed by the Contractor in the laydown area away from the river at the site. The proposed design of the excess wet concrete washout basin shall be submitted to the Contract Administrator for approval. The basin shall be formed by substantial berms of imported sand and material excavated for the basin shall be used to form a berm around the basin or stockpiled for future use in restoration. Hardened excess concrete, cement grout and uncontaminated washings in a disposal basin shall be removed for disposal as concrete rubble if the capacity for the basin is reached before completion of the Work.

- .7 The concrete washout basin and surrounding area shall be restored upon completion of the Work. Loose or exposed concrete reinforcing steel or iron and other steel wastes shall be recycled by the Contractor. The Contractor shall collect the recycle metal wastes arising on site. Preference shall be given to constructive reuse of uncontaminated granular material no longer required for project.
  - .8 Quantities of construction lumber and wood products wasted during construction shall be minimized. Every reasonable effort shall be made to reuse waste or surplus wood. Waste wood that cannot be reused or given away shall be disposed of at an MECP-approved local landfill site.
  - .9 Operating fluid wastes arising on site from vehicles and construction equipment shall be collected in suitable containers with tight sealing lids and shall be removed from site for recycling or disposal as hazardous waste.
  - .10 Wastes shall be properly labeled according to WHMIS regulations. Uncontaminated collected and excavated sediment shall be removed from the site for disposal as inert fill or as construction garbage. Collected and excavated sediment contaminated, or suspected to be contaminated by environmentally harmful substances shall be removed from site. The criteria, procedures, terms and conditions for disposal of contaminated sediment shall be those set out in current MOECC regulations and guidelines. Hazardous, subject and contaminated solid and liquid wastes shall be disposed of off-site using licensed disposal agents and haulers. The Contractor shall be responsible for registration of all hazardous, subject and contaminated wastes under Regulation 347 of the Ontario Environmental Protection Act. Wastes shall be properly stored and labeled according to WHMIS regulations.
  - .11 There shall be no open or burning waste, etc., on site. The Contractor shall provide fire extinguishers for all mechanical equipment.
- .9 Site Surface Water Control
- .1 Direct pump storm water or run-off to settling ponds or sediment basins prior to discharge to adjacent storm sewers or watercourses.
  - .2 Provide settling ponds and sediment basins where needed.
  - .3 Control overflow rates from settling ponds or sediment basins to ensure minimum solids transportation.
  - .4 Provide straw bales, filter berms or sand bags as required to retard and filter run-off prior to discharge to storm sewers or watercourses.
  - .5 Intercept and divert concentrated run-off from unstabilized areas under sheet flow conditions.
  - .6 Do not direct any flow of water across or over pavements, except through approved pipes or properly constructed troughs.
  - .7 Keep gutters open at all times for surface drainage.
  - .8 Provide splash pads where water is discharged to watercourse.
  - .9 Dispose of water so as not to be injurious to public health and safety, to property or to any part of work completed or under construction.
- .10 Surface Water Quality Protection
- .1 The Contractor shall ensure that no sediments, waste substances or materials resulting from work activities enter the surface water bodies or ditches/channels etc. connecting to them.

- .2 All work affecting any watercourse or water body shall cease upon a spill of sediment to a receiving watercourse or water body. A spill of sediment is defined as a release of sediment to a receiving watercourse or water body such that the level of sediment is increased by more than 15mg/L (TSS) above the background level at the point of discharge. The Contractor may initially assess the level of suspended solids by visual observation and subsequently confirm these observations by sampling and testing. The ruling of the Contract Administrator on the visually assessed level of in-water sediment constituting a spill shall be binding in the absence of the results of tests conducted at the time of discovery of a potential spill. All necessary measures shall be taken by the Contractor to stop the release. The Contract Administrator will not allow work to resume on the task which resulted in the release until the site operations of the Contractor have been reviewed and procedures acceptable to the Contract Administrator for continuing the work on the particular task have been established.
  - .3 The Contractor shall prevent grout, drilling, or other materials from entering watercourse or water bodies.
  - .4 The Contractor shall report to the Contract Administrator without delay all observed release of sediment to an adjoining watercourse or water body upon their discovery and shall immediately take measures to effectively stop such releases and prevent the occurrence of a sediment spill. All spills of sediment shall be dealt with and reported as required by the spill reporting requirements in this specification and as required by regulation.
  - .5 Accidental chemical or equipment operating fluid spills which may enter a water body shall be cleaned up immediately by the Contractor and reported as required as detailed in this specification and as required by regulation.
- .11 Sediment, Erosion and Dust Control
- .1 The Contractor shall be responsible for sediment, erosion and dust control on the site both on land and watercourses and water bodies adjoining and/or affected by the Work. The Contractor shall provide and maintain all sediment, erosion and dust control installations as required by site conditions and/or as required from time to time by the Contract Administrator.
  - .2 The Contractor shall be responsible for the design, operation and maintenance of all sediment, erosion and dust control facilities to meet the requirements of the Contract Documents, regulations and approvals granted for this project specified. The Contractor shall review its designs and plans for sediment control with the Contract Administrator at the start of the Work and prior to critical stages of the Work as it progresses.
  - .3 Containment, settling and/or direct filtering techniques shall be used to control suspended solids in all site discharge water and runoff and to contain work area sediment releases in water, as necessary to meet the water quality requirements as detailed in this specification. Turbid water in pump discharges shall be passed through filter socks or bags as the primary sediment retention system for dewatering pump discharges.
  - .4 The Contractor shall take measures to ensure that a stable base, not prone to erosion, is provided at all times in laydown, work and other areas which are or become, prone to disturbance. Erosion and sediment control measures such as silt fences and straw bale barriers shall be

- used in drainage and runoff areas on land and without dewatering areas as required by site conditions.
- .5 The Contractor shall install silt fences, silt curtains and other sediment control structures. Silt fences shall be installed around the laydown area prior to commencement of construction activities and mobilization of equipment and materials.
  - .6 Unless detailed otherwise in the Contract Drawings or Specification, the silt fence and filtering system design shall conform to the following specifications:
    - .1 Silt fence design shall be by Contractor. "Snow" fencing lined with filter fabric shall be attached to posts securely set in the ground. Silt fence filter fabric shall be Terrafix 270 R synthetic fibre fabric or equivalent approved by the Contract Administrator.
    - .2 Filter material for use as filter socks or bags on dewatering pump discharge hoses or for use in settling basin overflow weirs shall be comprised of Terrafix 370 RS synthetic fibre fabric or approved equivalent. Filter socks and filter bags shall have a minimum surface filtering area of not less than 80 times the cross-sectional area of the discharge hose to which they are attached.
    - .3 Clogged, ruptured or otherwise ineffective filter socks and filter bags shall be replaced without delay to maintain the serviceability of dewatering pump discharge filtering systems.
  - .7 A visual inspection of the sediment, erosion and dust control measures shall be completed daily and repairs to any damages to be completed immediately upon identification.
  - .8 All stockpiles shall be protected against erosion.
  - .9 Dusts shall be controlled for the duration of the Work.
  - .10 Regular mechanical sweeping, environmentally acceptable dust suppressants and/or water shall be used as necessary to control dust on the access road and in laydown and work areas.
  - .11 Oils shall not be used for dust control.
  - .12 The Contractor shall not use chemical dust suppressants.
  - .12 Spill Contingency Planning
    - .1 The Contractor shall endeavour at all times throughout the Work to prevent spills, and provide in the event of a spill, the best response within the shortest possible time.
    - .2 Environmental legislation with respect to spills treats sediment releases to water as spills detrimental to the natural environment. Sediment releases to a watercourse or water body are therefore included in the same category as spills of pollutants.
    - .3 The Contractor shall designate an Emergency Response Coordinator (ERC) from suitably qualified member of its site workforce. The Contractor shall submit the name of the ERC for review and concurrence.
    - .4 Sorbent booms shall also be provided and kept readily available at near-water work areas for local deployment as a precautionary measure.
    - .5 Sorbent material shall be on hand at all work areas, at equipment storage or parking areas and at all refueling locations as a means of containing and soaking up any spill substance before it reaches the groundwater table or open water.

- .6 Unless otherwise approved by the Contract Administrator, drip and spill trays shall be constructed of metal or rigid moulded plastic. Drip and spill trays shall be effectively of one-piece construction, have no leaks and shall not be readily deformable.
- .7 Empty open-head drums with sealable lids shall be provided on site for predisposal storage of spillable substances and for disposal of used sorbents, contaminated soil, etc. A minimum of four 205-L nominal size disposal drums shall be provided and suitably located on site.
- .8 The Contractor shall provide a minimum of two complete spill kits to be located in the principal work areas. The exact location of any spill kit within a work area may vary but a kit shall always be located in close proximity to the actual work zone and shall be readily accessible.
- .9 The Contractor shall be responsible for reporting spills. All spills shall be reported to the Contract Administrator immediately following their discovery and attention to immediate safety and containment concerns. All spills to the natural environment shall be reported to the Contract Administrator and the MECP (Spills Action Centre 1-800-268-6060) and other external agencies.
- .10 The Contractor shall submit written spill notification reports to the Contract Administrator within not more than 2 working days after the discovery of a spill.
- .11 All spills to the natural environment resulting from action or inaction on the part of the Contractor or its subcontractors shall be the responsibility of the Contractor. All testing required by the Contractor, the Contract Administrator or MNR in connection with a spill shall be the responsibility of the Contractor.
- .12 Excess grout and other liquid waste products shall be directed to secure containment facilities for subsequent removal and disposal in accordance with these Specifications and all applicable regulations.
- .13 **Work Near Water**
  - .1 The Contractor is prohibited from working within water bodies without obtaining approval from the MNR. Working includes but is not limited to the placement of permanent or temporary structures, traversing through this area with equipment or material, depositing any material within the river.
  - .2 It is the responsibility of the Contractor to fully familiarize itself with water level and flow conditions in the water bodies along the project route and to anticipate the effects that any water levels and flows may have on the Work.
  - .3 The Contractor shall meet the water quality protection requirements and the erosion and sediment control requirements of this specification and all applicable regulations. Turbid water shall not be directly discharged to any surface water body.
  - .4 Any dewatering, water containment, settling and/or filtering and drainage facilities set up in work areas shall be removed in their entirety upon completion of the Work. Collected and excavated sediments shall be carefully removed for disposal requirements in accordance with this specification and all applicable regulations.
  - .5 Where geotextiles and plastic geomembranes are used, they shall be removed in their entirety on completion and disposed of at an approved local landfill. Geotextile containing contaminated sediment shall be

disposed of in accordance with this specification and all applicable regulations.

### **1.3 Tree Maintenance**

- .1 Do not fall or trim trees without written authorization of Contract Administrator, or unless shown in the drawings as requiring removal.
- .2 Do not allow machinery or store materials within drip line of any tree that is to be saved.
- .3 Erect snow fencing around drip line of trees to be saved that are in close proximity to work.
- .4 Employ qualified workmen to cut and trim trees.
- .5 Use an approved pruning paint where limbs have been trimmed.
- .6 Existing trees on property are to be protected from damage during building constructions and renovations. Provide necessary barriers, tarpaulins etc. to adequately protect garden and landscaped areas.
- .7 Comply with all site boundaries identified by the Contract Administrator and restrict soil and vegetation disturbance to only those areas necessary to complete work as outlined in contract documents.

**End of Section**

## 01600 Materials and Equipment

### 1.0 General

#### 1.1 Description

- .1 Requirements for supply and installation of materials and equipment.

#### 1.2 General

- .1 When specified standards or authorities are mentioned in specifications or where authorities have jurisdiction over equipment or installations specified herein, chemical and physical properties of all material, design, performance, characteristics and methods of construction of all items of equipment to be in accordance with applicable Standard Specifications issued by these authorities.
- .2 Where more than one unit of similar equipment is required, all units to be of same manufacture. All component parts of unit of equipment need not be of same manufacture, but where more than one similar component is required, they must be of same manufacture. All material and equipment to be considered with regard to availability of spare parts and service, to approval of the Contract Administrator.
- .3 Store all materials and equipment in locations without interference to Owner's existing operations.
- .4 All material and equipment must be new and not reused unless approved by Contract Administrator.

#### 1.3 Specified Equipment

- .1 Generally, materials and items of equipment are specified and defined in specifications or on drawings by manufacturer's name, type and catalogue number. Use only these materials or items of equipment.
- .2 Items of equipment or materials selected by Contractor from specified, to be essentially of same type of construction, materials, arrangement, capacity and performance as described in specifications. Do not exceed space allotments shown on drawings.
- .3 Assume full responsibility for any additional installation costs resulting from use of specified equivalent equipment.

#### 1.4 Alternative Equipment

- .1 This is a "Base Bid" contract. The Tender Price for this contract shall be based on the "Base Design Manufacturer" equipment as specified in the Contract Documents. Alternatives to the named equipment will only be considered by the Owner following the award of the Contract.
- .2 Refer to Section 01035 for additional information in relation to the submission procedure and other requirements and obligations of the Contractor as it relates to alternative equipment.

#### 1.5 Review of Materials and Equipment

- .1 Unless otherwise indicated, provide Contract Administrator within seven (7) days after notification of award of contract with list of manufacturers or materials and equipment to be furnished, including any alternative items which have been accepted, and arrange to review and discuss same with Contract Administrator at their mutual convenience. Thereafter, make no change to approved list.

- .2 If manufacturer's list should fail to be submitted within seven (7) days, it is understood that manufacturer specified for each item of equipment will be furnished.
- .3 Assume all responsibility for proper and satisfactory performance and delivery of equipment ultimately selected unless Contractor advises Contract Administrator in writing of his objections to specified manufacturer prior to award of contract.

## **1.6 Testing/Samples**

- .1 Submit, in duplicate unless otherwise noted, samples as specified in Specification Sections. Label samples as to origin and intended use in the Work.
- .2 Deliver samples pre-paid to the Contract Administrator's business address or testing company as directed.
- .3 Notify the Contract Administrator in writing at the time of submission of any deviations from the requirements of the Specifications and state the reason for the deviations.
- .4 Adjustments made on samples by the Contract Administrator are not intended to change the Contract Price. If adjustments affect the value of the Work, state such in writing to the Contract Administrator prior to proceeding with the Work.
- .5 Make changes in samples that the Contract Administrator may require, consistent with the Contract Documents.
- .6 Where changes or modifications of the Products represented by the sample are required, re-submit samples to verify the required changes.
- .7 Where colour, pattern or textures are criteria, submit a full range of samples.
- .8 Reviewed samples will become the standard of workmanship against which the Work performed will be verified and accepted.
- .9 Refer to Section 01300 Submittals.

## **1.7 Workmanship**

- .1 Execute all work using only mechanics skilled in respective trade. Licensed journeyman millwrights must be included among those performing work on this Contract. Be familiar with work of other trades where it affects work of a trade. Take all required measurements at site and co-operate with all other trades concerned to ensure proper working of all details.
- .2 Make such slight alterations as may be necessary to make adjustable parts fit to fixed parts.
- .3 Cut and patch as required for installation of any work and leave other work in as good condition as found. Do not cut or weld to structural parts unless approved by Contract Administrator.
- .4 Mount all attachments to structural parts securely by clips designed for particular load with adequate safety factor.
- .5 Before commencing work, examine all areas and surfaces on which or against which work is to be applied. Notify Contract Administrator in writing if not in proper condition to receive work. Commencement of work constitutes acceptance of surfaces and any defect found after to be corrected at no additional cost.
- .6 Adequately protect all work from damage until final completion of contract. Remove, replace or make good any sustained or damaged work to satisfaction of Contract Administrator at no additional cost.
- .7 Maintain premises in clean and orderly condition during construction. Promptly remove all waste and unusable materials from site.

## **1.8 Delivery and Handling**

- .1 Arrange for early deliveries necessary for execution of work without delay. Have all material and equipment ready for job well in advance of time it is to be needed. Ensure equipment and material delivered has been reviewed per contract requirements prior to bringing on to site.
- .2 Do not schedule delivery of materials and equipment that require storage on site until such storage space is available.
- .3 Deliver, store and handle materials and equipment to exclude foreign material and prevent damage, rusting, soiling or breakage.
- .4 Store all materials and equipment that are required to be protected from weather.
- .5 Deliver all packaged materials in packages with manufacturer's seals and labels intact.

## **1.9 Storage on Site**

- .1 Location of storage areas are to be within the project work area as shown on the drawings.
- .2 Store materials and equipment such that they are protected from deterioration and damage.
- .3 Store materials and equipment in accordance with manufacturer's recommendations.
- .4 Make good any deterioration or damage that has occurred during storage at no additional cost.
- .5 Refer to Section 01500 and 01585 for additional requirements related to storage on site.

## **1.10 Removals of Materials and Equipment**

- .1 All materials and equipment for incorporation into the works shall be the property of the Owner, and the Contractor and Sub-Contractors are prohibited from removal or disposal of such without the written consent of the Contract Administrator.
- .2 No surplus or other material arising from any portion of the work shall be sold or disposed of without the written consent of the Contract Administrator. If such disposal occurs, the Contract Administrator may estimate the quantities and value of such materials and deduct that amount from the Contractor's next progress payment.
- .3 All excavated and demolished materials of value to, or required by, the Owner shall be neatly piled or spread in a location indicated by the Contract Administrator. The costs of such material handling shall be borne entirely by the Contractor.

**End of Section**

## 01650 Safety Review and Equipment Commissioning

### 1.0 General

#### 1.1 Description

- .1 Outlines requirements for Start-up of equipment and processes covered under this Contract, as well as commissioning services for equipment supplied.
- .2 Commissioning shall normally proceed in four (4) steps:
  - .1 Commissioning of individual components and equipment forming subsystems, ready for subsystem operations (Covered in this Section).
  - .2 Commissioning of subsystems and the overall facility in its entirety and running through all modes of operation.
  - .3 Demonstration and training of the operations of individual components, equipment, subsystems and the overall facility (Covered in this Section).
  - .4 Turn-over of facility to the Owner (Covered in this Section).
- .3 Each step of the above sequence will be completed to the satisfaction of the Engineer prior to proceeding to the next step in the sequence.
- .4 The Contract Administrator reserves the right to be present for and observe all inspection, testing and commissioning activities.

#### 1.2 Related Work

- .1 Section 01010 Summary of Work
- .2 Section 01210 Prestart Health and Safety Report.
- .3 Section 01680 Physical Checkout: Shop and Field Testing.
- .4 Section 01730 Operation and Maintenance Manuals.
- .5 Division 11 Equipment.
- .6 Division 15 Mechanical.
- .7 Division 16 Electrical.
- .8 In the case of conflict, the more stringent shall apply.

#### 1.3 Contractor's Testing & Commissioning Representative

- .1 Designate and furnish one or more Contractor's personnel to coordinate and expedite testing and equipment commissioning.
- .2 Such person or persons shall be present during equipment testing and equipment commissioning meetings and shall be available at all times during the testing and the equipment commissioning and performance evaluation period.
- .3 The Contractor shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the Manufacturer's recommendations. The Contractor shall provide to the Contract Administrator one (1) Adobe Acrobat format file (\*.pdf) copy (not including hard copies required as per Section 01730) of the certification

from the manufacturer's representative. In addition, a hard copy of all certification documentation should be kept in one binder at a location to be determined.

- .4 The Contractor shall generate and provide to the Contract Administrator a field report on start-up, commissioning, tests performed, test values experienced, etc.
  - .1 Email hand-written copy of the field report to the Engineer immediately after the tests are performed, and place one (1) copy in the above-mentioned binder;
  - .2 Not later than one (1) week after start-up and commissioning is complete, provide one (1) Portable Document Format file (\*.pdf) final copy of the report to the Engineer. This is in addition to the requirements of the Operation and Maintenance Manuals.

#### **1.4 Pre-Start Health and Safety Review**

- .1 The Contractor shall ensure that a Pre-Start Health and Safety Review of all installations and constructions in the Contract, as required and as specified in Section 01210, is completed.
- .2 The Pre-Start Health and Safety review shall be completed prior to the issuance of, and as a condition of, Substantial Completion or prior to the Operating Authority taking on responsibility for operating the facility, or parts thereof, whichever comes first.
- .3 Total price for this service shall include all reports and follow-up inspections, as required.

#### **1.5 Manufacturer's Field Services**

- .1 Contractor shall provide and pay for the services of manufacturers' representatives to perform the specified services.
- .2 Related requirements specified elsewhere:
  - .1 Inspections and testing required by laws, ordinances, rules, regulations or orders of public authorities: Conditions of the Contract.
  - .2 Certification of products: The respective sections of specifications.
  - .3 Test, adjust and balance of equipment: The respective sections of specifications.
  - .4 Field tests required and standards for testing: The respective specification sections.
  - .5 Operating and Maintenance Data: Section 01730.
- .3 Qualification of Manufacturer's Representative
  - .1 Authorized representative of the Manufacturer.
  - .2 Experienced in the application and installation of the subject equipment.
- .4 Services provided by Representative
  - .1 Visit the site:
    - .1 Inspect, check and adjust equipment as required and approve installation.
    - .2 Be present when equipment is tested on water for the two (2) day performance run.
    - .3 Be present when equipment is being tested on sewage during Facility Commissioning and placed in operation.

- .4 Revisit the site as often as required to correct all problems and until equipment installation and operation are acceptable to Engineer.
- .2 Instruct Owner's personnel in the operation and maintenance of the equipment in accordance with Section 01730.
- .3 Provide one (1) Adobe Acrobat format file (\*.pdf) copy (not including hard copies required as per Section 01730) of written report to Engineer, through Contractor, certifying that:
  - .1 Equipment is properly installed and lubricated.
  - .2 Equipment is in accurate alignment.
  - .3 Equipment is free from any undue stress imposed by connecting piping and anchor bolts.
  - .4 Equipment has operated satisfactorily under full load conditions.
- .4 Certify installation meets the requirements of the Contract Documents and shop drawings.

## **1.6 General Equipment Commissioning**

- .1 Manufacturer's field services for equipment specified in the Schedule herein are in addition to any services specified in other Sections.
- .2 Arrange with suppliers of equipment specified to provide services of manufacturer's authorized representative. Authorized representative to have a minimum of 3 years' experience with the equipment or product installed and cannot be a Subcontractor to the Contractor. Representative is to be present at the Site to inspect, check and approve equipment and system installation prior to startup.
- .3 Notify the Supplier and Contract Administrator fourteen (14) days in advance of the date when startup is to take place. The Site visit may be concurrent with the check of satisfactory installation if mutually agreed by the Supplier, Contractor and Contract Administrator.
- .4 Manufacturer's representative shall make a detailed check of the installation, including alignment, bolt tensions, belt tensions, running clearances, lubrication, workmanship and all other components as required to ensure proper operation of equipment.
- .5 Promptly remedy any defects to the satisfaction of the manufacturer's representative. Equipment shall be run and tested in the presence of the manufacturer's representative, Contractor and Contract Administrator.
- .6 Operate equipment for at least four (4) hours (or as specified in the Contract Documents) to demonstrate operations of the equipment and controls over several cycles, and take necessary remedial steps to ensure satisfactory operations.
- .7 Contractor to provide complete Manufacturers Installation Certification Form (11050-A) / Pre-Commissioning Certification Form (11050-B) and signed certification from the manufacturer's representative indicating that equipment is installed as intended by the manufacturer and is ready for start-up. Refer to Section 11050 for additional requirements and forms.

## **1.7 Equipment Testing**

- .1 Preparation:
  - .1 General:

- .1 Complete installation before testing, including all related manufacturer's representative services.
- .2 Furnish qualified manufacturer's representatives, when required by individual specification sections, to assist in testing.
- .3 Obtain from equipment manufacturer's representative the Manufacturer's Certificate or letter of proper installation when required by individual specification sections.
- .4 Schedule equipment testing and equipment commissioning meetings to discuss test schedule, plan of test, materials required, facilities operations interface, and Owner involvement.
- .5 Provide temporary valves, gauges, piping, test equipment and other materials and equipment required to conduct testing.
- .6 Provide written documentation, on Contractor's form, of functional and performance test results for each piece of equipment tested. Provide space on form for Engineer's signature that testing is complete
- .2 Cleaning and Checking: Prior to beginning functional testing:
  - .1 Calibrate testing equipment in accordance with manufacturer's instructions.
  - .2 Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
  - .3 Check power supply to electric-powered equipment for correct voltage.
- .3 Ready-to-test determination will be by Engineer based at least on the following:
  - .1 Notification by Contractor of equipment readiness for testing.
  - .2 Receipt of acceptable testing plan.
  - .3 Receipt of acceptable Operation and Maintenance Manuals.
  - .4 Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
  - .5 Adequate completion of Work adjacent to, or interfacing with, equipment to be tested, including items to be furnished by Owner.
  - .6 Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
  - .7 Satisfactory fulfillment of other specified manufacturers' responsibilities.
  - .8 Equipment and electrical tagging complete.
  - .9 Delivery of all spare parts and special tools.
- .4 Functional Testing:
  - .1 Conduct as specified in individual specification sections.
  - .2 Notify Owner, Engineer, and manufacturer's representative in writing at least 10 days prior to scheduled date of testing.
  - .3 If, in Engineer's opinion, equipment meets the functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by the individual specification sections.

- .5 Performance (Commissioning) Testing:
  - .1 Conduct as specified in individual specification sections.
  - .2 Notify Engineer and Owner at least fourteen (14) days prior to scheduled date of test.
  - .3 Performance testing shall not commence until the equipment is approved by Engineer as having satisfied the functional test requirements specified.
  - .4 Follow approved testing plan and detailed procedures specified.
  - .5 Source and type of fluid, gas, or solid for testing shall be as specified.
  - .6 Unless otherwise indicated, furnish all labor, materials, and supplies for conducting the test and taking all samples and performance measurements.
  - .7 Prepare performance test report summarizing test method and results.
  - .8 If, in Engineer's opinion, equipment meets the performance requirements specified, such equipment will be accepted as to conforming with the Contract requirements.

## 1.8 Equipment Performance (Commissioning) Evaluation

- .1 General:
  - .1 Support Owner's operations personnel throughout the Equipment Performance Evaluation Period.
  - .2 All equipment shall be accepted by Engineer as having met the requirements of specified functional testing prior to equipment commissioning.
  - .3 Sequence each unit process to the point that the complete equipment is operational for evaluation of unit process and equipment performance.
  - .4 Demonstrate proper operation of required interfaces within and between individual unit processes.
  - .5 Provide sufficient Subcontractor and equipment manufacturers' staffing to prevent delays.
  - .6 Schedule ongoing Work so as not to interfere with or delay the completion of equipment commissioning.
  - .7 After the equipment is operating, complete performance testing of those items of equipment not previously tested.
- .2 Equipment Performance (Commissioning) Evaluation Plan:
  - .1 Develop a plan in conjunction with Owner's operations personnel detailing step-by-step instructions for commissioning of each equipment.
  - .2 Include method evaluation and overall performance report for each equipment.
  - .3 Plan shall consist of bound copies of Commissioning and Performance Evaluation Forms. Use one form for each unit process; use example form attached, or one of Contractor's design.
  - .4 Commissioning and Performance Evaluation Form will minimally include the following:
    - .1 Description of equipment being energized.

- .2 All components and devices included with the equipment.
- .3 Contractor Certification that equipment is capable of performing its intended function(s).
- .4 Space for evaluation comments.
- .3 Owner Responsibilities:
  - .1 Assist Contractor in developing an Equipment Performance Evaluation Plan detailing step-by-step instructions for commissioning of each unit component and device.
  - .2 Operate process units and devices, under direction of the Contractor until recognition of substantial performance.
  - .3 Provide labor and materials as required unless indicated otherwise.
- .4 Equipment Commissioning Period:
  - .1 Adjust, repair, and correct as required to complete equipment commissioning.
  - .2 Significant Interruption: Includes any of the following events:
    - .1 Failure of Contractor to provide and maintain qualified onsite commissioning personnel as scheduled.
    - .2 Failure of any critical equipment that is not satisfactorily corrected within five (5) hours after failure.
    - .3 Failure of any noncritical equipment that is not satisfactorily corrected within eight (8) hours after failure.
    - .4 As may be determined by the Engineer.
  - .3 A significant interruption will require the commissioning then in progress to be stopped and restarted after corrections are made.
  - .4 Automatic and computerized operation.

### **1.9 Process Equipment Commissioning**

- .1 Commissioning shall be performed by Contractor, in the presence of the Contract Administrator, Operator and Owner's personnel. Contractor's appointed commissioning supervisor is to lead the commissioning group of Contractor personnel, Subcontractor personnel and manufacturer/Supplier representatives. Refer to Section 01010 for a general outline of sequence of work, which is meant as guidance only.
- .2 During the commissioning and demonstration period and only to the extent that systems are not connected to existing systems (i.e, temporary pumping line), only the Contractor shall be responsible for operating process areas. The Contract Administrator and Owner's personnel shall only observe and receive operations instructions.
- .3 The Contractor is not to operate any existing works. Coordinate operations of existing components, equipment or subsystems with the Owner's Operator; operation of any part of an existing system shall be performed only by the Operator for that system.
- .4 In the event that the commissioning, demonstration, or training period has to be extended because of the malfunctioning of or problems with equipment, the Contractor shall be responsible for all costs arising out of any extension of time at no additional cost to the Owner.
- .5 Inform all Subcontractors and Suppliers/manufacturers of the requirements herein and include all costs for the required services in the Contract Price. Where a

minimum amount of time is stated in the Specifications for a manufacturer's services, any additional time required to perform the specified services satisfactorily shall be at no additional cost to the Owner.

#### **1.10 Demonstration**

- .1 Demonstrate operations and maintenance of each system to Contract Administrator and Owner's staff. Instruction to be by a qualified manufacturer's representative who is knowledgeable about the instrument, equipment or subsystem.
- .2 Demonstrate startup, operations, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each component or piece of equipment at scheduled time to Contract Administrator and Owner's staff.
- .3 During the demonstration period, the Contractor shall demonstrate that operations of the facility as a whole is correct and in accordance with the Contract requirements by demonstrating individual components, equipment and subsystem.
- .4 All malfunctions, alarms, safety devices, interlocks and annunciation, which exist as actual field devices or which may exist as programmable logic control (computer programming), shall be demonstrated by simulation of conditions as necessary.
- .5 Should the demonstration reveal any defects, then such defects shall be promptly rectified by the Contractor and the demonstration of the equipment repeated to the satisfaction of the Contract Administrator. Should such repeat demonstration require a second or subsequent visit to the Site by the Contract Administrator and/or Owner's personnel, then the additional costs incurred shall, at the discretion of the Contract Administrator, be paid for by the Contractor.
- .6 All components shall be demonstrated over the entire range of operations specified, including variations in flow, pressures, speeds and controls.

#### **1.11 Training**

- .1 Provide a training program to the Owner, Operator and any designated personnel assigned for operations and maintenance of the facility. Training program plan and time shall be submitted within 3 months after award of contract for review and comments by Contract Administrator and Owner.
- .2 Arrange with suppliers of equipment for the provision of a qualified manufacturer's representative to provide training for the Operator's personnel.
- .3 Coordinate and establish with each Supplier and Subcontractor the time period necessary to complete training of Operator's staff. The minimum time for any one session to be allowed for by the Supplier shall be four (4) hours. Contractor to assume two (2) separate training sessions to accommodate shift workers.
- .4 Arrange for the provision of these training sessions by the Supplier and Subcontractor through the Contract Administrator, who will coordinate the necessary arrangements with the Owner.
- .5 Training must be provided prior to substantial performance and/or the commissioning of any equipment to be operated by Operations staff prior to substantial performance.
- .6 A summary of training sessions performed, including a sign-off location for the Operator to indicate he has been trained for each session, shall be provided by the Contractor prior to acceptance of training completion by the Contract Administrator.

**1.12 Turnover**

- .1 Turnover of the facility to the Owner for operation by the Operator shall occur only upon completion and acceptance by the Contract Administrator of all required reviews, demonstrations, and documentation of the operations of the facility.

**End of Section**

## 01650-A Manufacturer's Installation Certification Form

Contract No: \_\_\_\_\_ Specification Section: \_\_\_\_\_

Equipment name: \_\_\_\_\_

Contractor: \_\_\_\_\_

Manufacturer of equipment item: \_\_\_\_\_

The undersigned manufacturer of the equipment item described above hereby certifies that a qualified individual has checked the installation of the equipment and that the equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturers recommendations and that the trial operation of the equipment item has been satisfactory.

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_  
Date

\_\_\_\_\_  
Manufacturer

\_\_\_\_\_  
Signature of Authorized Representative

\_\_\_\_\_  
Date

\_\_\_\_\_  
Contractor

\_\_\_\_\_  
Signature of Authorized Representative

## 01650-B Pre-Commissioning Certification Form

Contract Name: \_\_\_\_\_ Contract No.: \_\_\_\_\_

Process System Name: \_\_\_\_\_

List each equipment item included in the process system. Attach marked Piping Schematics and/or P&ID indicating specific items and system limits.

Equipment Name (Including Item No.)	Equipment No.	Manufacturer

The Contractor certifies that operational testing of the process system is complete and that the process system has been cleaned and made ready for commissioning.

The contractor hereby transfers operation and maintenance of the process system to the Owner for commissioning. This transfer does not relieve the Contractor of any contractual obligation to the Owner. The Contractor will assist the Owner and provide required support during commissioning as specified in Division 1.

This document is not to be construed as Substantial Completion or Notice of Acceptance.

### Request for Transfer

\_\_\_\_\_  
Contractor                                      Signature of Authorized Representative                                      Date

### Acceptance of Transfer

\_\_\_\_\_  
Owner    Signature of Authorized Representative    Date

## 01660 Special Project Procedures

### 1.0 General

#### 1.1 Safety Equipment and Safety Protocol

- .1 Provide safety equipment such as ropes, safety harnesses, combustible/hazardous gas and oxygen depletion meter for the use of the Contract Administrator. Provide casual labour to Contract Administrator when entry is required to manholes or other areas which may be hazardous. Contract Administrator is not allowed to enter such areas alone.
- .2 Develop a written safety protocol as part of the requirements indicated in General Conditions for work that involves entering and exiting hazardous locations in accordance with Ontario Ministry of Labour legislation. As a minimum the safety protocol shall include:
  - .1 List of equipment required.
  - .2 List of names of people trained and certified to work in confined spaces.
  - .3 Number of people (including their training) standing-by and ready to assist with evacuation of personnel from the confined space work area in case of emergency.

#### 1.2 Protection, Soundness and Repair of New Construction

- .1 Protect newly constructed work from damage. Prevent heavy loading of newly constructed work and repair damage. Construct works watertight and correct rejected work.
- .2 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.

#### 1.3 Protection of Existing Structures and Property

- .1 The Contractor will be held fully responsible by the Owner for any damage to utilities, properties, buildings, homes, or structures adjacent to or in the general area of the work, through settlement of ground, vibration or shock resulting from any cause relating to the work carried out under this Contract. Make good and repair such damage at own expense.
- .2 Control of Vibrations
  - .1 Control vibration levels to prevent damage to concrete work during construction, existing structures, adjacent homes, equipment, and utilities.
  - .2 The Contract Administrator reserves the right to require additional restrictive limits for vibration control if recommended by the inspection agency.
- .3 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.

- .4 Provide access to all fire hydrants to satisfaction of local authority.
- .5 Provide and maintain gas and water services, flow of all sewers, drains, house or inlet connections, and all watercourses which are encountered during progress of work.
- .6 Repair immediately all sewers and drains that are damaged or broken.
- .7 If gas or water mains or services are damaged or broken, stop flow of gas or water from pipe and immediately notify utility company who will repair or supervise and inspect repair of damaged main or service.
- .8 Whenever construction approaches indicated location of buried services, carefully excavate by hand in advance of trench excavation to expose buried pipes, cables, conduits, structures, etc.

**1.4 Protection Against Flotation**

- .1 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.

**1.5 Valves, Cuts in Piping, Vessels, etc.**

- .1 Ensure that no open process pipes, holes, etc. are left at end of work day in tankage or when ceasing work (even temporarily), provide end cap or suitable plug to withstand the force of any liquid flow which may be directed to cut out area under normal, abnormal or emergency conditions. Ensure all valves are closed on piping to mitigate pressure loss and backflow issues.

**End of Section**

## 01680 Physical Checkout: Shop and Field Testing

### 1.0 General

#### 1.1 General

- .1 Section covers requirements for physical checkout; shop and field testing.

#### 1.2 Description

- .1 Physical inspection and testing requirements in this Section are in addition to requirements of Divisions 11 through 16.
- .2 Perform testing prior to Substantial Completion and in a logical order to allow for overall commissioning of system.
- .3 Provide following checkout and testing activities:
  - .1 Physical checkout and inspection of equipment and materials to verify conformance of installed equipment and materials to specifications.
  - .2 Shop testing of equipment specified in Divisions 2 to 16 and this Section.
  - .3 Field testing of equipment specified in Divisions 2 to 16 and this Section.
  - .4 Submit checkout plan to Contract Administrator covering checkout and testing process specified in this Section.

#### 1.3 Definitions

- .1 Shop testing: testing performed by Supplier at place of manufacture, place of assembly, or at location where required testing apparatus is located, for purposes of proving that products meet specified requirements. Administrative procedures for shop testing are specified in this Section. Technical requirements for shop testing are specified in respective Sections. Minimum acceptable test criteria are specified in this Section.
- .2 Field testing: testing performed by subcontractors with supplier assistance on installed products after performance of physical checkout, for purposes of proving that tested products meet specified requirements. Perform field testing regardless if shop testing was performed on equipment or material. Administrative requirements for field testing are specified in this Section. Technical requirements for field testing are specified in respective Sections. Minimum acceptable test criteria are specified in this Section.
- .3 Physical checkout: process of physically inspecting products after installation to determine if products are satisfactorily installed, ready for field testing. Requirements for physical checkout are specified in this Section and/or respective Sections (if applicable).
- .4 Supplier's representative or manufacturer's representative: qualified, experienced and trained person or persons provided by supplier providing technical and/or process related advice, and/or assistance, relating to installation or utilization of products provided by supplier. Training and experience include minimum of three (3) years participation in similar work including not less than three similar projects during that 3-year period.

#### **1.4 Roles and Responsibilities**

- .1 Provide outside services, materials, labour supplies, test equipment and other items necessary to perform specified testing.
- .2 Arrange for and provide participation or assistance of survey crews, engineers, quality control technicians, supplier's representative(s) and required governmental agency representatives.
- .3 Provide services of supplier's representative(s) as follows:
  - .1 Assistance during installation as specified in Divisions 2 to 16 and this Section.
  - .2 Shop testing as specified in Divisions 2 to 16 and this Section.
  - .3 Field testing as specified in Divisions 2 to 16 and this Section.
  - .4 Supplier's representative activities required by this Section are in addition to supplier training requirements (if applicable) and other specified services. Timing for performance of these services is defined in this Section.
  - .5 Contract Administrator will review and comment on Contractor's deliverables, participate in physical inspection activities, witness shop and field testing, and provide verification of conformance to Contract Documents.

#### **1.5 Check Out Plan**

- .1 Submit checkout plan based upon specified requirements.
- .2 Submit one (1) Adobe Acrobat format file (\*.pdf) copy of preliminary checkout plan within twenty-one (21) days of order to commence work and provide revised plan ten (10) working days prior to proposed testing. Plan defines following:
  - .1 Logical and systematic performance of physical inspections, shop, field and functional tests including:
    - .1 Chronological schedule of testing and inspection activities.
    - .2 Checklist of inspection and testing activities broken down by location, discipline, system and device or item.
    - .3 Index which cross-references forms to intended application(s).
    - .4 List of shop tests, supplier certifications, including those required by applicable Sections. Include provisions for re-testing if required.
  - .2 Participants in testing.
  - .3 Special test equipment.
  - .4 Sources of test media (potable water, high pressure effluent water, power, gas, air).
  - .5 Proposed method of delivery of media to equipment to be tested.
  - .6 Ultimate disposal of test media.
- .3 Contract Administrator may modify or revise checkout plan. Continue to update checkout plan, working in conjunction with Contract Administrator prior to start of scheduled equipment checkout and functional testing activities. Obtain written approval for each specific element of plan at least two (2) weeks prior to actual commencement of testing.

## 1.6 Minimum Shop and Field Testing Requirements

The following details acceptable checkout requirements if no references to procedures are made or no procedures for shop and field testing are contained in Specification for following test parameters. Should these requirements conflict with supplier's recommendations or be less stringent than supplier's requirements, they shall be superseded by supplier's requirements for checkout and testing.

- .1 Measurement of shaft run out for rotating equipment requiring assembly:
  - .1 Remove bearings from shaft. Support shaft on pedestal rollers or in lathe.
  - .2 Check each shoulder on shaft.
  - .3 Take minimum of two readings for each shoulder, opposed to each other by 90°.
  - .4 If measured clearances are within supplier's specifications for new installations, replace and recheck shafts out of round or out of specified tolerance.
- .2 Vibration measurement:
  - .1 Conduct torsional and vibration analysis of equipment in accordance with respective Sections.
- .3 Coupling shaft alignment:
  - .1 Perform final alignments and checks with dial indicator or laser device. Feeler gauges and straight edges are not acceptable.
  - .2 Eliminate soft foot conditions prior to aligning.
  - .3 Correct displacements in excess of 0.508 mm when checking for final soft foot.
  - .4 Realign pipe with displacements in excess of 0.508 mm when checking for pipe strain.
  - .5 Alignments will not be regarded as final until grout is set and piping is attached. Demonstrate alignment is not changed by attachment of piping.
  - .6 Shim driving element, never driven element.
  - .7 Take bracket sag corrections into account when using dial indicator. Determine bracket sag on rigid pipe.
  - .8 Mount dial indicator to driven element so that it can be rotated. Rotate both elements while aligning.
  - .9 Align gear reduction elements with driven element first, then align driver to gear reduction element when aligning three coupled elements.
  - .10 Check all alignments; i.e. angular alignment in vertical and horizontal planes and parallel alignment in vertical and horizontal planes.
  - .11 Minimum acceptable alignment accuracy for flexible couplings is  $\pm 0.127$  mm or supplier's specifications, whichever is more stringent.
  - .12 Align dial indicator perpendicular to alignment surface.
  - .13 Number hold down nuts prior to tightening. Loosen in reverse order. Tighten in ascending order.
  - .14 Use clean, deburred shims. Clean machine base and feet from rust or burrs prior to alignment.

- .4 Measurement of noise (dBA):
  - .1 Eliminate noise sources generated by adjacent construction activity prior to testing.
  - .2 Establish background noise level prior to testing.
  - .3 Perform noise level testing on installed devices required by respective Sections.
  - .4 Conform to Occupational Health and Safety Act O.Reg. 381/15, for the noise exposure limit of less than 85 dBA.
- .5 Electrical equipment:
  - .1 Testing standards for electrical components are specified in Division 16 and Drawings.

#### **1.7 Witnessing of Tests**

- .1 Provide minimum of five (5) business days' notice to Contract Administrator so that Contract Administrator and/or Owner may witness shop and field tests. Contract Administrator and Owner may witness performance of any tests, at their option. Contract Administrator's or Owner's witnessing of tests does not relieve Contractor of obligation to comply with specified requirements.

#### **1.8 Shop Testing**

- .1 In lieu of shop testing, provide to the Contract Administrator certified curves representing the guaranteed performance of all equipment to be installed under this Contract. These curves shall be submitted a minimum of thirty (30) days prior to shipment of the equipment.
- .2 Curves provided shall be clear and shall address all projected modes of operation.

#### **1.9 Field Testing of Equipment**

- .1 Provide the services of experienced and authorized representatives of the manufacturer of each piece of equipment, if specified in respective Sections, to visit site and inspect, check, adjust if necessary and approve equipment installation.
- .2 Arrange to have manufacturer's representative revisit site as often as necessary until all trouble is corrected and equipment installation and operation are satisfactory to Contract Administrator.
- .3 Require that each manufacturer's representative furnish to Contract Administrator a written report addressed to Owner certifying that equipment was properly installed and lubricated, is in accurate alignment, is free from undue stress imposed by connecting piping or anchor bolts and was operated satisfactorily under full-load conditions.
- .4 Arrange for manufacturer's representative to provide written authorization that equipment can be operated as intended.
- .5 Be responsible for scheduling operations testing.
- .6 Contract Administrator and Owner's operating personnel will witness operations testing.
- .7 Arrange for manufacturer's representative to instruct Owner's operating personnel in correct operation and maintenance procedures. Schedule instruction at time arranged with Owner at least ten (10) business days in advance of when equipment is fully operational. Provide on-site instruction with qualified persons who are familiar

- in advance with equipment and systems in plant. Furnish Owner's manuals required under Section 01730 prior to scheduling operations testing.
- .8 Make supporting systems operational prior to field testing of equipment.
  - .9 Unless otherwise specified, furnish personnel, power, water, chemicals, fuel, oil, grease and other necessary equipment, facilities and services required for conducting tests.
  - .10 Perform field testing in addition to, and not in lieu of, shop testing.
  - .11 Perform field testing as part of overall physical testing process and in accordance with approved checkout plan. Provide five (5) business days written notice indicating date and time for testing each piece of equipment or series of equipment pieces. Submit following items with notice for approval by Contract Administrator:
    - .1 Description of tests, specifically outlining how test will conform to Specifications including test forms.
    - .2 Testing devices to be used in tests. Indicate what portion of tests that devices will perform or measure and device accuracy. Submit sample measurement results and catalog cutsheets.
    - .3 Personnel used to perform tests. Submit resumes, qualifications and experience. Personnel must have three (3) years experience with manufacture and operation of equipment to be tested and will have participated in minimum of five (5) similar tests during this period.
    - .4 Schedule of testing, including frequency of measurements, personnel present and contingency plans for equipment and/or test failure.
    - .5 Material and equipment required for test. Supply material and equipment at no additional cost to Owner.
    - .6 Identify water and power requirements in plan. Supply water and power for field testing purposes only, unless otherwise specified. Provide temporary piping and wiring required for field testing.
    - .7 Including valve positions, set-ups, temporary arrangements required to run tests so that Contract Administrator can anticipate and plan for testing situation.
  - .12 Incorporate comments on procedures, equipment or personnel prior to testing. Resubmit major comments of field test procedure and proposed test date. Contract Administrator will notify Contractor in writing if formal resubmission is required with transmittal of review comments.
  - .13 Provide two (2) business days written notice to Contract Administrator prior to actual start of field testing. Include statement that equipment and facilities to be tested were thoroughly inspected and cleaned of construction debris or other extraneous materials and lubrication, materials and preparations are completed.
  - .14 Submit following to Contract Administrator within five (5) business days after completion of tests for approval:
    - .1 Completed test forms for each device tested.
    - .2 Approved completed certification documentation.
    - .3 Written summary of testing, reporting on results and summarizing entire procedure.
    - .4 Schedule for retesting, if necessary. Perform retesting required to fulfill intent of Specifications at no additional cost to Owner.

### **1.10 Physical Checkout and Inspections**

- .1 Physical checkout and inspections provide verification of conformance to Contract Documents for physical presence, dimensions, location for proper materials, parts and items, integrity of materials, equipment and systems to determine their condition and readiness for field and/or functional testing.
- .2 Inspection includes following elements, as applicable:
  - .1 Concrete structures for structural integrity, finish, tolerance, durability, appearance, embedded and inserted items.
  - .2 Mechanical systems and items for installation, alignment and securing, adjustments of packing and seals, lubrication, drive connection and alignment, motor rotation, belt/chain tension, painting or surface applications, and tagging for identification.
  - .3 Electrical and control/instrumentation systems for conduit and tray installation, wire/cable material and size, circuit identification, terminal installation and identification, major switches, circuit breakers and components and labeling for system identification.
- .3 Inspection will verify that tanks, pipes, conduits, equipment, systems, areas and other items provided under Contract are clean and free from debris or materials which interfere with subsequent testing requirements or routine operations. Correct unsatisfactory conditions prior to testing or acceptance.
- .4 Submit one (1) Adobe Acrobat format file (\*.pdf) copy (not including hard copies required as per Section 01730) of each completed inspection form, signed by authorized representative of Contractor who participated in inspection upon completion of inspection. Contract Administrator will review the forms.

### **1.11 Connections to Work**

- .1 Correct items of work failing to meet specified requirements, at no additional cost to the Owner.
- .2 Correct non-conforming items by re-work, modification or replacement to option of Contract Administrator including provisions of required labour, materials and requirements for specified retesting, to verify that items conform with Contract Documents.
- .3 Any costs due to retesting of any corrected works, as well as any costs incurred by the Owner in engineering, investigation and administration or other activities due to the imperfect work, shall be the responsibility of the Contractor.

### **1.12 Safety**

- .1 Conduct specified test procedures in compliance with applicable safety standards and regulations.

**End of Section**

## 01700 Contract Closeout

### 1.0 General

#### 1.1 General

- .1 Protect existing services, property, and natural environment during construction.
- .2 Restore to original condition all damaged facilities and property including roadways, curbs and gutters damaged or disturbed by construction operations.
- .3 All Operation and Maintenance manuals, record drawings (as-constructed), Prestart Health and Safety Report, all start-up & commissioning reports, and Final ESA Approval Certificate are required prior to issuance of substantial completion.

#### 1.2 Restoration and Cleanup

- .1 At completion of work, clean-up to include but not necessarily be limited to:
  - .1 Remove and dispose where applicable all surplus products, tools, instructions, machinery, equipment and debris from site.
  - .2 Clean and remove all dust, dirt, scratches and marring defects from all mechanical and electrical equipment.
  - .3 Remove all wire, metal clippings or other debris from any place on site.
  - .4 Should any pipe or other part of systems be stopped by any foreign matter, disconnect, wherever necessary for the purpose of locating and removing obstructions. Clean and reconnect. Repair work damaged in removing obstructions.

#### 1.3 Training

- .1 Provide training to Owner's staff in the operation and maintenance of equipment and instrumentation in accordance with Section 01650. Duration of the training sessions shall be as specified under the individual equipment specification. Include cost of training in the Tender price for the related equipment.

#### 1.4 Take-Over Procedure

- .1 Test and commission all equipment and sub-systems as per Sections 01010, 01650 and 01680 and Section 11050.
- .2 Placing into Service:
  - .1 Assist in starting up new facilities under direction and supervision of Owner.
  - .2 Arrange to have sufficient labour and technical personnel on site in addition to that requested under equipment section.
  - .3 Date of Substantial Completion to be considered only after satisfactory operation of all equipment and whole system. Take note of special testing and acceptance requirements contained in equipment specifications and allow for same in tender price.
  - .4 Carry out all field tests of equipment prior to plant start-up and allow in Tender Price for all field testing costs.

- .5 Field testing refers to checking and operating, where possible, all equipment prior to placing plant into service.
- .6 Start-up will not commence until Contractor has field tested all equipment.

### **1.5 Warranty Period**

- .1 Except where indicated otherwise in the Specifications, the Contractor shall warranty all work performed under this Contract, including equipment installed, for a period of twelve (12) months from date of Substantial Completion.
- .2 The Contract Administrator will arrange and conduct with the Owner and the Contractor a warranty inspection at the site prior to the expiration of the twelve (12) month warranty period.
- .3 The Contractor shall co-ordinate any site visits required for correction of deficiencies so as to minimize the impact on operation of facilities.

### **1.6 Operating Manuals**

- .1 Refer to 01730 for requirements.

### **1.7 Construction Record Drawings**

- .1 During progress of construction, keep record of all work and transfer to a set of drawings kept on site for this sole purpose. Do not use these drawings for daily working purposes. **Status and review of record drawings will be discussed at the progress meetings to ensure that this information is being recorded as the project progresses.**
- .2 Prior to substantial completion all final and approved record drawings to be turned over to the Contract Administrator.
- .3 A complete set of as-built drawings shall be prepared and submitted as detailed in Section 01780 at project completion. Payment for completed record/as-built drawings is identified as a separate item in the Tender Price 48-hour breakdown provided by the Contractor.

**End of Section**

## 01730 Operation and Maintenance Manuals

### 1.0 General

#### 1.1 General

- .1 Section covers requirements for operation and maintenance (O&M) manuals, including operating procedures and plant safety as well as equipment operation and maintenance manuals.

#### 1.2 Number and Format

- .1 Upon completion of installation and testing, Contractor to submit:
- .2 Three (3) hard copy sets of the "Operation and Maintenance" manuals contained in new, clean "D" Ring binders, either originals or legible copies (colour originals shall be copied in colour).
- .3 Three (3) USBs each containing electronic versions of the entire "Operation and Maintenance" manuals. All files are to be in Adobe Acrobat format, latest version and unsecured as to allow for printing. MS Word version of the Process Control Narrative is required on each USB.
- .4 Binder to have title "Operation and Maintenance Manual - INDUSTRIAL PARK SPS" as well as Volume number and Volume title.

#### 1.3 Required Content

- .1 Complete information is to be included in each operation and maintenance manual submitted for:
  - .1 Each and every piece of equipment installed under this Contract, referred to by name and by tag number (as specified in Section 15190);
  - .2 All installed electrical/control components; and
  - .3 A functional description of the control method or interface with SCADA system (where applicable).
- .2 Where manufacturer's literature covers several models or options, highlight the applicable information and cross out any non-relevant information.

#### 1.4 Time of Submittal

- .1 Final copies of all required Operation and Maintenance Manuals (in the quantities stipulated in Clause 1.2 of this Section) are required to be submitted prior to Substantial Performance.

#### 1.5 Structure

- .1 The manual shall follow the structure outlined below:
  - .1 Title Page;
  - .2 Date, Owner, Contract Administrator, General and Major Sub-Contractor information;
  - .3 Table of Contents;

- .4 Supplier address, phone number, fax number, email address, website and item supplied; and
  - .5 Group 1,2,3, etc., - use numbered tab dividers for each group of items. Each group to contain the following information for each and every product and/or item of equipment used on the project as follows:
    - .1 Section 1
      - .1 Signed letter of certification that the equipment/product has been properly installed, serviced, is in proper running order and ready to operate (if applicable).
      - .2 Process Control Narrative
      - .3 Safety Procedures
      - .4 Copy of all inspection, start-up and commissioning reports (if applicable).
      - .5 Copy of all Warranty and Technical Service information.
    - .2 Section 2
      - .1 Reviewed shop drawings, outlines and descriptive literature.
    - .3 Section 3
      - .1 Installation and Operating Manual - Information for installing and operating each item of equipment/product.
      - .2 Maintenance Manual - Information for maintaining, adjusting, troubleshooting, repairing and dismantling each item of equipment/product.
      - .3 Parts Manual - to include parts schematic, reference numbers and part names, and a list of recommended spare parts. Also furnish address and phone number of nearest spare parts and service depot.
- Note: Identify all drawings and instructions by Project Title and Contract Number, etc.
- .2 The USB version of the O&M manual shall be laid out in the same format and the USB version shall be linked to each section and tabs such that the user can easily navigate and find the required information.
  - .3 Confirm layout with Contract Administrator prior to assembling documents for review.

**End of Section**

## 01780 Closeout Submittals

### 1.0 General

#### 1.1 General

- .1 As-built red line mark-up drawings, Operation and Maintenance Manuals, Final ESA Completion Certificate, and the Prestart Health and Safety Reports, in addition to completion of all commissioning and training activities, are required prior to substantial completion being issued for this contract. Upon substantial completion holdback will be released as outlined in the General Conditions.
- .2 Format:
  - .1 Document Files - as Adobe Acrobat format files (.pdf), latest version.

#### 1.2 Operation and Maintenance Manuals

- .1 Upon completion of testing submit three (3) hard copy sets and three (3) electronic versions of the entire "Operation and Maintenance" manual, as detailed in Section 01730 of this Contract.

#### 1.3 Construction As-Built Drawings

- .1 General
  - .1 General Contractor shall prepare and submit a complete set of red line markup drawings detailed in this specification.
  - .2 During progress of construction, Contractor to keep record of all work and transfer to a set of drawings kept on site for this sole purpose. Do not use these drawings for daily working purposes. Monthly inspections of the drawings may be undertaken by the Contract Administrator as aspects of the work are completed.
  - .3 Co-operate fully with Contract Administrator during progress of work so that all measurements can be taken or checked as necessary.
  - .4 Complete package of as-built mark-up drawings shall be submitted to the Contract Administrator for review. Review of partial package will not be considered. A maximum of two (2) submittals will be accepted for review.
  - .5 Review of as-built drawings by Contract Administrator as described above to be construed as gratuitous service to Contractor. Acceptance of Contract implies unequivocal responsibility by the Contractor for all construction changes from those furnished under the Contract.
  - .6 It is understood that as-built mark-up drawings are not considered reviewed, and the items covered rejected (even after installation) if, after review, it develops that:
    - .1 Drawings fall short of complete quality as judged by Contract Administrator with respect to items omitted, items that differ from those furnished under the Contract and/or items located or sized differently than as shown under the Contract.

- .2 Timely Submission
  - .1 As-Built drawings must be submitted, reviewed and accepted by the Owner prior to substantial completion. Failure to submit in ample time shall not be considered cause for any extension of Contract Time.

**End of Section**

**DIVISION 2**  
**SITE WORK**

## **Division 2 Site Work - Index**

*02000 General*

*02010 Site Preparation*

*02140 Dewatering and Site Drainage*

*02150 Shoring and Bracing*

*02200 Earthwork*

*02210 Grading*

*02221 Compaction Control & Testing*

*02240 Geotextiles*

*02600 Underground Piping*

*02830 Fences and Gates*

*02930 Lawns and Grass*

*02980 Restoration*

**End of Section**

## 02000 General

### 1.0 General

#### 1.1 Order of Priority

- .1 The instructions given in this Section are to be given precedence with regard to Contract interpretation over the following sections within this Division.
- .2 Notwithstanding clause 1.1.1 above, instructions given in Division 1 – General Requirements are to be given precedence with regard to Contract interpretation over those in this Division.

#### 1.2 Intent of Specifications

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.2.2 of this Section at no additional cost to the Owner except as allowed at the sole discretion of the Engineer.

#### 1.3 Engineer and Contract Administrator

- .1 In this Division, Engineer and Contract Administrator are deemed to have the same meaning, except in reference to requirements for Engineering Services provided by others under the various specification sections.

#### 1.4 Submission of Alternate Proposals for Products or Materials

- .1 If the Contractor requests use of an alternate product or material, then he/she is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract in accordance with Section 01035.
- .2 If an alternative product or material is accepted for use, then the Contractor is responsible at his/her cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .3 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.

#### 1.5 References to Standards

- .1 If references to standards appear in this Division, it is the intention of these Specifications to refer to the standard that was in effect at the time of the tender close for this Contract regardless of the date or version of the standard stated in the Division.

**2.0 Products**

**2.1 Not Applicable**

**3.0 Execution**

**3.1 Not Applicable**

**End of Section**

## 02010 Site Preparation

### 1.0 General

#### 1.1 Description

- .1 Requirements for site preparation including clearing, grubbing, tree removal and relocation, stripping and grading of site.

#### 1.2 Regulations

- .1 Abide by laws and regulations of the Province, Territory and/or Municipality in which the work is located, particularly with regard to fire regulations and public safety.
- .2 Perform work under observation of Regulations of the Occupational Health and Safety Act of Ontario Ministry of Labour.
- .3 The Contractor is responsible for posting of warning signs; supply and placing of barricades and protective hoarding.

#### 1.3 Definitions

- .1 Clearing:
  - .1 Cutting off to not more than a specified height above ground and disposing of all fallen timber and surface debris.
- .2 Grubbing:
  - .1 Excavating and disposing of stumps and roots to not less than a specified depth below original ground surface.
- .3 Site:
  - .1 The area of property on which works are to be constructed, specifically the Melrose Booster Pumping Site and Monitoring Station chamber site.

### 2.0 Products

#### 2.1 Tree Paint

- .1 Use horticulturally accepted, non-toxic, non-hardening emission approved by Engineer.

### 3.0 Execution

#### 3.1 General

- .1 Do not fell or trim trees not clearly indicated for removal or trimming on the contract drawings without written authorization of Contract Administrator.
- .2 Report any discrepancies between site condition from tender close date and date of start work order within one week of start work order issuance or it will be assumed that the site condition is as per the condition at tender close date and as anticipated in the Tender documents.

### **3.2 Clearing and Grubbing**

- .1 Clear and grub site.
- .2 Identify and protect significant environmental features and wildlife habitats before clearing and grubbing.
- .3 Clear trees, shrubs, brush, vegetation, fences, abandoned surface utilities and other debris where necessary.
- .4 Grub embedded boulders, pavement, stumps, foundations and logs where necessary.
- .5 Break up and remove existing foundations and buried pipe and utilities within line of work.

### **3.3 Pruning**

- .1 Obtain permission from Engineer prior to pruning.
- .2 Employ a licensed arborist to carry out pruning.
- .3 Use clean and sharp tools.
- .4 Make cuts flush to main branch or trunk, smooth and sloped to prevent accumulation of water.
- .5 Apply approved tree paint to all cut surfaces immediately after pruning.

### **3.4 Removal and Disposal**

- .1 Dispose of unwanted material off site.

### **3.5 Stripping Topsoil**

- .1 Remove topsoil from work area or as directed by Engineer.
- .2 Clear area prior to stripping topsoil.
- .3 Remove topsoil carefully to depth specified or directed by Engineer.
- .4 Do not mix topsoil with subsoil or other materials.

### **3.6 Stockpiling Topsoil**

- .1 Stockpile topsoil in areas approved by Engineer. Protect stockpiled material with silt fence to control sediment and erosion control. Stockpiled material is to be kept free of vegetation. This may require tarping of piles or treating the topsoil pile to control weed growth.
- .2 Do not place topsoil in or near tree stands, along flood plains and in areas containing natural wildlife habitats.
- .3 Construct perimeter drainage ditches to intercept and divert runoff to adjacent discharge area.
- .4 Protect stockpiles to ensure minimum environmental interference in accordance with Division 1.

### **3.7 Tree Location**

- .1 Examine site of work to determine location and size of existing trees and shrubs to remain, to be relocated or to be removed.
- .2 Mark shrubs and trees to remain.
- .3 Protect trees with tree protection fencing around drip line.

- .4 Every effort shall be made to retain as much existing vegetation as possible in all areas.

**End of Section**

## 02140 Dewatering & Site Drainage

### 1.0 General

#### 1.1 Summary

- .1 Comply with Division 1 General Requirements, Section 01500 1.16 and OPSS 517. Where those requirements conflict, the most stringent shall apply.
- .2 Section Includes
  - .1 Control of groundwater and surface run-off.
  - .2 Discharge of drainage water from construction site.
  - .3 Coordinating dewatering work with requirements of other trades and units of work affected by dewatering operations.
- .3 Payment
  - .1 No additional payment for dewatering will be allowed regardless of conditions encountered.
  - .2 No payment will be made for normal dewatering, considered to be up within the limits of an Environmental Activity and Sector Registry (EASR), carried out during construction of structures, pipelines and appurtenances. This will be considered part of the item and incidental to the project.

#### 1.2 Definition

- .1 Subgrade: Surface to which excavations are made for the purpose of construction of the Work in accordance with the Contract Documents. Subgrade as defined does not include additional depths of excavation that may be required or ordered to obtain suitable foundation conditions.

#### 1.3 System Description

- .1 Design and Performance Requirements
  - .1 Prevent surface run-off from entering excavations. Construct ditches, berms, and similar items as required to direct water away from excavation. Do not allow silt laden run-off water to enter watercourses. Direct run-off flows to siltation ponds or catchment areas.
  - .2 Maintain groundwater level a minimum of 300 mm below subgrade level, or lower as may be required, to permit placing geotextiles, concrete mud mat, granular construction working surface, concrete, and similar items, on firm dry undisturbed subgrade.
  - .3 Maintain groundwater at required level until all of the following conditions are met:
    - .1 Substructure is completely built.
    - .2 Backfilling to final grade is complete.
    - .3 Underdrains, rock anchors, and other permanent devices which protect the structures against buoyancy are operational.
  - .4 Prevent destabilization, heaving, or shear failure of the sides and bottom of excavation.
  - .5 Prevent damage to or displacement of structures from groundwater pressures.

- .6 Repair or replace any structure or Works damaged due to dewatering at no expense to the Owner.
- .2 Dewatering and Site Drainage Discharge Requirement
  - .1 Provide appropriate filter screens so that no soil or foundation material is removed, and solids concentration of less than 5 ppm in the discharge water is achieved. Do not exceed solids concentration in the discharge water of 10 ppm at any time.
  - .2 Provide discharge siltation ponds of required size to allow sufficient detention time so that the decanted water will meet provincial regulations. Discharge water from run-off collection and dewatering operations to siltation ponds located at strategic points on the site as identified on the dewatering and drainage plan submitted as required under Clause 1.4 of this Section.
  - .3 Maintain siltation ponds during construction period by removing silt build up from time to time to keep siltation ponds functional.
  - .4 The Owner will carry out physical analysis of drainage water to establish conformance with provincial regulations. If directed by the Contract Administrator, treat the drainage water so that it meets provincial regulations before discharging into the watercourse.
  - .5 Discharge drainage water to existing watercourse and prevent erosion of existing banks by energy absorption devices, such as rock dams.
  - .6 Provide siltation fence where shown on the drawings and additional erosion control devices as may be required to prevent the discharge of soil and other materials to the storm sewer system and to the watercourse.

#### 1.4 Submittals

- .1 Shop Drawings
  - .1 Submit a general plan of dewatering and site drainage scheme which includes:
    - .1 Location of generators and other noise producing equipment and anticipated decibel levels.
    - .2 Relationship between dewatering equipment, new and existing structures, the excavation plan, and excavation shoring systems (if applicable).
    - .3 Location of dewatering discharge points.
    - .4 Location and dimensions of siltation ponds.
    - .5 Details of screens and filter media.
    - .6 Details of surface drainage system.
    - .7 Details of erosion control systems.
  - .2 These submittals are for record purposes only and will not be reviewed for performance adequacy. Submit drawings of proposed dewatering systems for Contract Administrator's review.
- .2 Permit to Take Water
  - .1 Environmental Activity and Sector Registry (EASR)
    - .1 Dewatering in excess of 50,000l/day requires obtaining an EASR registration with the MECP in accordance with Ontario Regulation 64/16 made under the Ontario Water Resources Act through the Ministry's web-based Environmental Activity and Sector Registry (EASR). For the purpose of this project an EASR will be obtained by the owner.

- .3 Dewatering Discharge Approval
  - .1 Apply and obtain dewatering discharge approval from the Ontario Ministry of Environment and Climate Change to comply with the Ontario Water Resources Act.
- .4 Local Conservation Authority Requirements
  - .1 Comply with all requirements of local Conservation Authority.
- 1.5 Site Conditions**
  - .1 Contractor to review and confirm site conditions prior to tender close.
- 2.0 Products**
- 2.1 Equipment**
  - .1 Dewatering Equipment
    - .1 Pipes, pumps, electrical generators, and other equipment.
    - .2 Standby pumps and generator with effective muffling devices to keep noise levels at or below background noise levels. In any event, do not exceed a noise level of 55 dB at property lines.
- 3.0 Execution**
- 3.1 Installation**
  - .1 Contractor is to provide own means of power generation to run dewatering and other required equipment.
  - .2 When directed by the Contract Administrator to sub-excavate because of unsuitable subgrade condition, dewater and monitor effectiveness of dewatering before proceeding to sub-excavate.
  - .3 Take corrective measures as required to maintain groundwater at a sufficiently low level to meet performance requirements.
  - .4 Flotation of Structures
    - .1 Maintain groundwater at a sufficiently low level to prevent damage or displacement of structures by groundwater pressures.
    - .2 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.
- 3.2 Field Quality Control**
  - .1 Monitoring Groundwater Level
    - .1 At all times accurately record the amount of water being dewatered to confirm daily rate taking whether a PTTW is in force or not.

### **3.3 Compliance**

- .1 Comply with all regulatory requirements, and conditions of approval for permits issued for this work. Particular attention is called to Ontario Regulation 903 with regard to proper installation and decommissioning of all wells utilized on this project.

**End of Section**

## 02150 Shoring & Bracing

### 1.0 General

#### 1.1 Description

- .1 Requirements for supplying, placing and maintaining shoring and bracing required to support and protect sides, bottom and roof (if any) of an excavation where necessary or where ordered by Engineer.

#### 1.2 Reference Standard

- .1 Ontario Provincial Standard OPSS 538 and 539.

#### 1.3 1.3 Related Work Specified Elsewhere

- .1 Section 02200 Earthwork
- .2 Section 02600 Underground Piping

#### 1.4 Submittals

- .1 Submit design drawings and supporting data to Engineer for review at least two weeks prior to commencing work. Drawings must be signed and sealed by a licensed Professional Engineer in the Province of Ontario.

#### 1.5 Statutory Requirements

- .1 Comply with Occupational Health and Safety Act and Regulations for Construction Projects of Ontario.

#### 1.6 Contractor's Responsibilities

- .1 Provide, place and maintain such shoring and bracing at such locations and elevations as are necessary or required to:
  - .1 Support and protect sides, bottom and roof (if any) of excavation,
  - .2 Prevent any disturbance for weakening of supporting material below or beside the works,
  - .3 Prevent movement of ground which may disturb or damage works, adjacent pavements, property, structures or other works,
  - .4 Prevent inflow of groundwater or soil into excavation,
  - .5 Protect and maintain at all times traffic along Vanneck Road and Wynfield Gate as per the specifications and drawings. Contractor to provide appropriate traffic control in accordance with MTO Book 7.
- .2 Follow procedures for extracting shoring and bracing and placing backfill to ensure that backfill load is applied gradually and disturbance of works or foundation material is avoided.
- .3 Contractor is not relieved of any responsibility by absence of direction from Engineer or Inspector regarding shoring and bracing or by approval or disapproval by Engineer or Inspector of measures taken by Contractor.

## **1.7 Basis of Payment**

- .1 Include cost of shoring and bracing in tender price in Form of Tender for construction of works.

## **2.0 Products**

### **2.1 Materials**

- .1 Steel
  - .1 Use steel piling, steel beams, adjustable struts of strengths, qualities, dimensions and designs required.
- .2 Timber
  - .1 Use timber free from cracks, shakes and large or loose knots, sound, straight, of dimensions and grade required.
- .3 Trench box
  - .1 Contractor to ensure the approved shop drawing for any trench boxes onsite complete with an engineers stamp, licensed in the province of Ontario is supplied to the Contract Administrator and a copy shall be available onsite for review.

## **3.0 Execution**

### **3.1 Installation**

- .1 Drive and place shoring and bracing so that it can be removed as backfilling takes place without damage to works and without settlement of, or damage, to adjacent pavements and structures.
- .2 Trench boxes are to be installed in accordance with the Occupational Health and Safety Act.

### **3.2 Removal**

- .1 Remove shoring as excavations are being backfilled unless directed otherwise by Engineer.
- .2 Do not remove bracing until backfill reaches level of bracing.
- .3 Remove shoring in 150 mm (6") increments until safely clear of pipeline or structure.
- .4 Remove shoring once clear of pipeline or structure in increments that ensure backfill is 500 to 1000 mm (20" to 40") above toe of shoring.
- .5 Cut off all shoring left in place as specified or directed by Engineer.

**End of Section**

## 02200 Earthwork

### 1.0 General

#### 1.1 Description

- .1 Requirements for excavating and backfilling for structures, pipelines, appurtenances, roadwork, swale construction and general grading.
- .2 Comply at all times with the Occupational Health and Safety Act and Regulation

#### 1.2 Related Work Specified Elsewhere

- .1 Section 02221 Compaction Control & Testing
- .2 Section 02511 Asphalt Pavement

#### 1.3 Definitions

- .1 Earth Excavation:
  - .1 All excavation including removal of frozen earth other than rock excavation.
- .2 Additional Excavation and Backfill:
  - .1 All excavation and backfill ordered in writing by Contract Administrator beyond that specified.
- .3 Excess Excavations:
  - .1 All excavation performed without written order of Contract Administrator beyond that specified.
- .4 Backfill:
  - .1 Fill material used below subgrade or finish grade.
- .5 Native Site Material:
  - .1 Any material obtained from excavating or grading under Contract.
- .6 Controlled Density Fill:
  - .1 A blend of Portland Cement, fly ash, aggregate and water.
- .7 Standard Proctor Density:
  - .1 As defined in ASTM D698.
- .8 Trench:
  - .1 As defined in Occupational Health and Safety Act and Regulations for Construction Projects of Ontario.
- .9 Rock Excavation:
  - .1 Removal of material from igneous, sedimentary, or metamorphic rock, which prior to removal, was integral with parent mass.
  - .2 Removal of boulders or rock fragments larger than one (1) cubic metre in volume.

#### **1.4 Cold Weather Work**

- .1 Obtain permission from Contract Administrator before starting excavation in frozen ground.

#### **1.5 Stability of Excavation**

- .1 Employ such construction methods, plans, procedures and precautions to ensure that excavations are stable, free from disturbance and, reasonably dry. Recommendations as described in the geotechnical investigation report should be taken into account. The Contractor shall investigate soil conditions and satisfy himself as to the conditions to be encountered.
- .2 Such construction methods shall include, but are not limited to:
  - .1 Interlocking steel sheeting and shoring.
  - .2 Normal temporary ground water control systems employing pumping from properly constructed sumps.
  - .3 Surface water or free water control systems employing ditches, stone drains, pipes and/or pumps.
  - .4 Soil stabilization methods employing stone rip rap and geotextile fabric.
  - .5 Temporary excavation protection required (see plan).
- .3 Employ such construction methods, plans and materials to ensure that migration of fine soil material into pipe bedding or sub-bedding from adjacent ground shall not take place. Do not use clear stone or other material with high proportion of voids for bedding or sub-bedding unless specified or ordered in writing by Contract Administrator for specific locations.
- .4 Follow procedures for trimming of sheeting, staging of excavation and ground water control to ensure the stability of excavation and existing structures.
- .5 Normal dewatering requirements for structure pipeline and appurtenances shall be included in the form of tender for each item and considered incidental to the contract.

#### **1.6 Stockpiling and Disposal of Excavated Material**

- .1 Stockpile all approved excavated materials at the approved storage areas. No material shall be stockpiled within the travelled portion of any roadway, shoulders or driveway areas. Stockpiles shall not impede the sight lines of vehicular traffic.
- .2 A limited amount of approved excavated material may be disposed of onsite as fill to meet new site grades. Material to be approved by the Contract Administrator/ Geotechnical Engineer. Grade and level fill area at completion of the project in a manner to provide positive drainage as directed by Contract Administrator.
- .3 Dispose of all unwanted excavated material off site in accordance with O.Reg. 406/19. Contractor is responsible to obtain written permission for disposal of excess fill material and must provide records
- .4 Grade and seed all stockpile and fill areas in accordance with Section 02930.

#### **1.7 Inspection**

- .1 Give ample notice and provide Contract Administrator with facilities for inspections.

#### **1.8 Testing**

- .1 Test to Section 02221.

## **1.9 Basis of Payment**

- .1 Payment for all work associated with this section to be included in the Lump Sum price for this project.
- .2 Payment for additional excavation and backfilling as directed by the Contract Administrator to be determined in accordance with procedures established in the Form of Tender and/or General Conditions.
- .3 No extra payment will be made for excess excavation needed on account of soil heaving at bottom of excavation due to improper dewatering procedures or collapse of excavation walls or for excavation as a direct result of the Contractors' own means and methods and not in relation to items outside their reasonable control.
- .4 No extra payment will be made for measures ordered by Contract Administrator to correct problems caused by excess excavation.
- .5 No extra payment will be made for hauling on any part of site or for hauling required in disposing of excavated material.
- .6 No payment will be made for hauling back to site excavated material suitable for backfill that has been removed from site.
- .7 No extra payment will be made for stockpiling or double handling of excavated materials.
- .8 No extra payment will be made for construction methods required to keep excavation stable, free from disturbance or dry.
- .9 No extra payment will be made for crushed stone or other granular material used to facilitate drainage or dewatering during construction of structure or for excavation related thereto.
- .10 No extra payment will be made for removal and replacement of soil weakened or disturbed by unsuitable construction methods or procedures or by action of workmen.
- .11 No extra payment will be made because of obstructions encountered during excavation except for old foundations not indicated on Drawings.
- .12 No extra payment will be made for excess excavation due to Contractor error.

## **2.0 Products**

### **2.1 Backfill Materials**

- .1 Native material:
  - .1 Excavated fine grained granular material (i.e. sands, silts and sandy silts) approved by Contract Administrator.
  - .2 Material free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter, rocks and boulders over 75mm in any dimension, or other deleterious materials.
- .2 Imported material:
  - .1 Material from source approved by Contract Administrator.
  - .2 Material free from frozen lumps, cinders, ashes, refuse, vegetable or organic matter rocks and boulders over 75mm in any dimension, or other deleterious materials.
- .3 Granular Materials:
  - .1 Granular "A": to OPSS 1010
  - .2 Granular "B" Type 1 or Type 2: to OPSS 1010

- .3 Clear stone
- .4 Rip Rap minimum 200mm diameter
- .4 Do not use any material without approval from Contract Administrator.
- .5 Do not use shale or thinly bedded limestone which may break up on exposure or freezing.

### **3.0 Execution**

#### **3.1 Dewatering**

- .1 Dewater excavation to Section 02140 and OPSS 517.

#### **3.2 Shoring and Bracing**

- .1 Shore and brace to Section 02150.

#### **3.3 Removal of Frozen Ground**

- .1 Do not use backhoe bucket or drop weight to break frozen ground.
- .2 Adopt method of removal of frozen ground that will not cause excessive noise, ground vibration, or damage to adjacent structures and utilities.

#### **3.4 General Excavation**

- .1 Excavate to lines, elevations and dimensions as indicated on Drawings or as directed by Contract Administrator.
- .2 Follow excavation procedures as indicated on Drawings, remove all fill and unsuitable material under pavement and structures as directed by the Contract Administrator.
- .3 Notify Contract Administrator if bottom of excavation appears to be unsuitable for foundation. Excavate unsuitable material as directed or agreed to by Contract Administrator until satisfactory foundation is attained. Backfill with approved granular material or concrete as directed. The exposed subgrade for new pavement and parking area should be properly shaped to promote drainage to catch basins and heavily proof-rolled. Any softened areas encountered during the proof-rolling should be sub-excavated and replaced with well compacted granular material.
- .4 Stockpile excavated materials suitable for backfill.
- .5 Separate materials that are unsuitable for backfill.
- .6 Perform corrective measures ordered by Contract Administrator to rectify deficiencies caused by excess excavation.
- .7 Backfill excess excavation beyond grades indicated under footings or structures to required grade with Class "C" 15 MPa concrete.
- .8 Remove and replace weakened or disturbed soil with 15 MPa concrete where excavated surface below or beside proposed structure is disturbed or weakened by unsuitable construction methods or procedures which may include inadequate control of ground water or free water or action of workmen at no extra cost.
- .9 Do not place any material in excavated area without approval of Contract Administrator.
- .10 For precast structures excavate materials to a clear distance of 300mm plus allowance for shoring and bracing where required.

- .11 Do not allow deep excavations to remain open at final excavations for protracted periods of time that may allow bottom heaving.
- .12 Do not excavate in unsound soil conditions without permission of Contract Administrator.

### **3.5 Trenching to OPSS 410 and 412**

- .1 Excavate trenches to lines, grades, elevations and dimensions specified or as directed by Contract Administrator.
- .2 Grades noted on the drawing reflect approximate surface grades. The Contractor shall install the forcemain generally based on these elevations but assuming a typical 1.5m cover such that the high point on the forcemain corresponds to the surface grade of 218.38m as noted. The Contractor will be required to supply and place the direct buried air release valve at this high point.
- .3 Excavate trenches so that width at bottom does not exceed width at top.
- .4 Notify Contract Administrator if bottom of trench appears to be unsuitable for foundation. Excavate unsuitable material as directed or agreed to by Contract Administrator until satisfactory foundation is attained and backfill with approved granular material.
- .5 Do not excavate more than 15 metres of trench in advance of completed pipeline.
- .6 Excavate trench completely and sufficiently far in advance of pipe laying to allow for proper installation of pipe.
- .7 Stockpile excavated material suitable for trench backfill.
- .8 Separate materials that are unsuitable for backfill.
- .9 Perform corrective measures ordered by Contract Administrator to rectify deficiencies caused by excess excavation.
- .10 Do not use trenching box if soil conditions or method of use are such that disturbance of soil, bedding or pipe occurs.
- .11 Remove and replace weakened or disturbed soil with approved granular material compacted to 98% maximum dry density in accordance with Standard Proctor Density where excavated surface below or beside proposed pipeline is disturbed or weakened by unsuitable construction methods or procedures which may include inadequate control of ground water or free water or action of workmen.

### **3.6 Backfilling**

- .1 For Backfilling of Pipe Trench:
  - .1 To be read in conjunction with details on drawings and pipe schedule in Section 02600.
  - .2 Place materials in layers not more than 300 mm thick, loose depth and wetted if required.
  - .3 Within boulevards, use clean, inorganic, dry, selected native materials compacted to 98% Standard Proctor Density.
  - .4 Within the roadway and up to 1 metre behind the back of curb, use Granular "A" compacted to 100% Standard Proctor Density.
- .2 For Backfilling Around Structures:
  - .1 Place backfill material in layers not more than 300mm thick, loose depth, and wetted if required.
  - .2 Place backfill materials uniformly and simultaneously on sides of structures.

- .3 Unless otherwise indicated on Drawings, compact each layer to 98% of maximum dry density in accordance with Standard Proctor Density.
- .4 Do not backfill cast-in-place concrete structure until approval has been obtained from Contract Administrator.

### **3.7 Backfilling Shored Excavations**

- .1 Withdraw sheeting gradually as backfilling progresses.
- .2 Do not remove bracing until backfill reaches level of bracing.
- .3 Place and compact backfill so as to fill voids left by pulled sheeting.
- .4 Place and compact backfill around and over sheeting left in place.

### **3.8 Support at Structures**

- .1 Where pipe is laid into a structure across an excavated area, provide one of the following:
  - .1 Backfill excavation below pipe with controlled density fill or 15 MPa concrete up to first pipe joint at undisturbed soil.
  - .2 Install reinforced concrete beam capable of supporting pipe and overburden between structure and undisturbed soil. Place backfill to level of underside of beam before placing beam.
  - .3 Provide a flexible pipe joint 300mm from outside face of structure, restrained to structure, unless indicated otherwise on the drawings.
  - .4 Except for sewer pipe, all process and other piping is to be provided with a flex connection as described in 3.9.1.3 above, and this will be the only accepted form of support.

### **3.9 Disposal of Materials**

- .1 Dispose of unsuitable excavated materials at approved disposal locations.
- .2 Transport materials so as to minimize spillage.

**End of Section**

## 02210 Grading

- 1.0 General**
- 1.1 Description**
  - .1 Requirements for rough and final grading.
- 1.2 Related Work Specified Elsewhere**
  - .1 Section 02200 Earthwork
  - .2 Section 02930 Lawns and Grass
- 2.0 Products**
  - .1 Not Applicable.
- 3.0 Execution**
- 3.1 General**
  - .1 Report any discrepancies between site condition from date of tender close date and date of start work order within one week of start work order issuance or it will be assumed that the site condition is as per the condition at tender close date and as anticipated in the Tender documents.
- 3.2 Rough Grading**
  - .1 Rough grade to levels, grades and contours allowing for surface materials as specified or directed by Contract Administrator.
  - .2 Do not disturb soil within drip line of trees and shrubs.
- 3.3 Final Grading**
  - .1 Final grade to lines and elevations as specified or directed by Contract Administrator.
  - .2 Final grade to smooth uniform surface within 25 mm of the required elevation.
  - .3 Correct surface irregularities by loosening and adding or removing materials.
  - .4 Rip-rap to be placed 1 m around all catch basins and DICBs outside of the paved or hard surfaces.

**End of Section**

## 02221 Compaction Control & Testing

- 1.0 General**
- 1.1 Description**
  - .1 Requirements for compaction control and testing throughout progress of work.
- 1.2 Reference Standard**
  - .1 Ontario Provincial Standard (OPSS 503)
- 1.3 Related Work Specified Elsewhere**
  - .1 Section 01020 Allowances
  - .2 Section 02200 Earthwork
  - .3 Section 03300 Cast-in-Place Concrete
  - .4 Section 03480 Pre-Cast Concrete Specialties
- 1.4 Definitions**
  - .1 Standard Proctor Density - As defined in ASTM D698.
- 1.5 Basis of Payment**
  - .1 Payment for initial inspection as defined in Division 1, Section 01020.
  - .2 Payment for retesting required due to unsatisfactory results shall be paid by the Contractor.
- 2.0 Products**
  - .1 Not Applicable.
- 3.0 Execution**
- 3.1 Material Testing**
  - .1 Testing of materials to be performed by independent testing agency retained by Municipality.
  - .2 Supply representative samples of granular materials for gradation test.
  - .3 Provide labour and equipment to obtain and handle samples.
- 3.2 Compaction Testing**
  - .1 Compaction tests to be performed by independent testing agency retained by Municipality.
  - .2 Testing to be performed throughout progress of work to determine adequacy of compaction. Co-operate with inspection staff during testing period.

**End of Section**

## 02240 Geotextiles

### 1.0 General

#### 1.1 Summary

- .1 This Section specifies the materials and installation methods to be used when geotextiles are specified for use or required by site conditions.

#### 1.2 Related Work Specified Elsewhere

- .1 Section 01300 Submittals
- .2 Section 02200 Earthwork
- .3 Section 02600 Underground Piping

#### 1.3 Reference Standards

- .1 CAN/CSA-G40.21-[M92], Structural Quality Steels.
- .2 CAN/CSA-G164-[M92], Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 AN/CGSB-4.2-[M88], Textile Test Methods.
- .4 CAN/CGSB-148.1, Methods of Testing Geotextiles and Geomembranes.
  - .1 No.2-[M85], Mass per Unit Area.
  - .2 No.3-[M85], Thickness of Geotextiles.
  - .3 No.7.3-[92], Grab Tensile Test for Geotextiles.
  - .4 No.6.1-[93], Bursting Strength of Geotextiles Under No Compressive Load.
  - .5 ASTM D 4491-[89], Test Methods for Water Permeability of Geotextiles by Permittivity.
  - .6 ASTM D 4595-[86], Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
  - .7 ASTM D 4716-[87], Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
  - .8 ASTM D 4751-[87], Test Method for Determining the Apparent Opening Size of a Geotextile.

#### 1.4 Samples

- .1 Submit samples in accordance with Division 1, Section 01300.
- .2 Submit to Contract Administrator following samples at least four (4) weeks prior to commencing work.
- .3 Minimum length of 2 m of roll width of geotextile.
- .4 Minimum of 1 m seam with at least 600 mm of geotextile on both sides of seam.

#### 1.5 Mill Certificates

- .1 Submit to Consultant copies of mill test data and certificate at least four (4) weeks prior to start of work as part of shop drawing submission.

## **1.6 Delivery and Storage**

- .1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

## **1.7 Measurement for Payment**

- .1 Geotextiles will not be measured for payment. They shall be included in the unit prices of the structures and paving items that they are associated with.

## **2.0 Products**

### **2.1 Material**

- .1 Geotextile to be Terrafix 270R woven synthetic fibre fabric and supplied in rolls with the following minimum dimensions:
  - .1 Width: 2 m minimum. Length: 5 m minimum.
- .2 Physical properties:
  - .1 Grab tensile strength and elongation: to CAN/CGSB-148.1, No.7.3-92.
    - .1 Breaking force: minimum 450 N, wet condition.
    - .2 Elongation at break: 70-100 %.
  - .2 Mullen burst strength: to CAN/CGSB-4.2, method 11.1-94, minimum 1.40 MPa.
  - .3 Tear strength: to CAN/CGSB-4.2, No.12.2-95 minimum 210 N.
- .3 Hydraulic properties:
  - .1 Filtration opening size (FOS): to ASTM D 4751, 50-150 micrometres.
  - .2 Permeability: to CAN /148.1 No. 14-94, minimum  $1.4 \times 10^{-1}$  K (cm/sec)
  - .3 Securing pins and washers: to CAN/CSA-G40.21, Grade300W, hot-dipped galvanized with minimum zinc coating of 600g/mto CAN/CSA G164.
  - .4 Factory seams: sewn in accordance with manufacturer's recommendations.
  - .5 Thread for sewn seams: equal or better resistance to chemical and biological degradation than geotextile.

## **3.0 EXECUTION**

### **3.1 Installation**

- .1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated and retain in position with securing pins and washers.
- .2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .4 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .5 Join successive strips of geotextile by sewing. Pin successive strips of geotextile with securing pins at 100 mm intervals at mid-point of lap.
- .6 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.

- .7 After installation, cover with overlying layer within four (4) hours of placement.
- .8 Replace damaged or deteriorated geotextile to approval of Contract Administrator.

**3.2 Protection**

- .1 No vehicles permitted directly on geotextile.

**End of Section**

## 02600 Underground Piping

### 1.0 General

#### 1.1 Description

- .1 Requirements for supply and installation of underground piping from the outside of a building or structure to its intended location, as described in these specifications and as shown on the Drawings.
- .2 The Contractor shall note that this contract includes underground piping as defined by these specifications, and additional underground piping as defined by the separate specifications for the road works. The Contractor shall review both specifications and the drawings to confirm the limits of each.

#### 1.2 Reference Standard

- .1 Ontario Provincial Standard Specifications including but not limited to OPSS 201, 206, 407, 409, 410, 416, 517 and 701.
- .2 Ontario Provincial Standard Drawings OPSD.
- .3 Southwest Middlesex Design Standards.

#### 1.3 Related Work Specified Elsewhere

- .1 Section 02150 Shoring and Bracing
- .2 Section 02200 Earthwork
- .3 Section 02140 Dewatering and Site Drainage
- .4 Section 02221 Dewatering and Site Drainage
- .5 Division 15 Mechanical

#### 1.4 Definitions

- .1 Bedding:
  - .1 Material used to support pipe below and up to spring line.
- .2 Cover Material:
  - .1 Material placed from top of bedding to minimum distance of 300mm above outside top of pipe.

#### 1.5 Protection Against Flotation

- .1 Prevent damage to pipeline due to hydrostatic pressure during construction and until completion of work.
- .2 Do not lay pipes on frozen ground.

#### 1.6 Basis of Payment

- .1 Payment for supply and installation of all underground piping work to be included in lump sum price bid in Form of Tender under Division 2.

- .2 All OPSS quantity measurements and basis of payments do not apply to this contract, for the underground piping included as part of this Division.

## **2.0 Products**

### **2.1 General**

- .1 Supply and install pipes in material, size and class as shown on Drawings and as indicated in Division 15.
- .2 Supply fittings suitable for and compatible with class and type of pipe with which they will be used.
- .3 Contractor shall verify all pipe length and fitting requirements.

### **2.2 Concrete**

- .1 To Section 03300 or as indicated on the Contract Drawings.
- .2 Cast-in-place and formed concrete to have 28-day compressive strength of 25 MPa unless otherwise indicated.

### **2.3 Reinforcing Steel**

- .1 Refer to Section 03200 Concrete Reinforcement.

### **2.4 Precast Catch Basins, Manholes and Valve Chambers**

- .1 Refer to Section 03480 - Precast Concrete Specialties

### **2.5 Pipe Bedding Materials**

- .1 Granular materials greater than 19 mm in size shall not be used for pipe bedding. Bedding material shall be as specified in the Contract.
- .2 Concrete for bedding shall conform to OPSS.
- .3 Where wet fine grained granular material are encountered at bedding zone, geotextile material meeting the requirements of OPSS Form 1860, Type I shall be used to envelop the "sewer stone" bedding (See also Section 02240 – Geotextiles). Once this change is made (mid run), this bedding system will be maintained until the next maintenance hole location regardless if the trench conditions improve. Trench conditions will be re-evaluated at the beginning of each run to determine if geotextile wrapped crushed stone is warranted.

### **2.6 Cover Materials**

- .1 Granular material shall be one of the following: Granular A, B, M, B select, Granular C and Coarse Sand shall conform to the requirements of O.P.S.S. 1010, unless otherwise specified in the Special Provisions.
- .2 Use Granular 'A' to OPSS Form 1010 as cover material for flexible pipe.
- .3 Use Granular 'B' Type II to OPSS Form 1010 for rigid pipe.

### **2.7 Backfill Materials**

- .1 Refer to "Section 02200 Earthwork".

## 2.8 Buried Gate Valves and Boxes

- .1 Valves
  - .1 Valve boxes shall be CI 130 mm screw type.
  - .2 Opening direction of the valves to be confirmed by Southwest Middlesex.
  - .3 Valves shall be gate valves conforming to AWWA C500 or resilient seat gate valves conforming to AWWA C509 / C515.
  - .4 All valves must be epoxy coated inside and out (minimum of 3 mm thickness) and conforming to AWWA C-550.
  - .5 Epoxy coated gate valves do not require anodes.
  - .6 All valves up to 200 mm diameter may be push-on joint, valves 250 mm to 400 mm must be mechanical joints to allow for adequate mechanical thrust restraints.
  - .7 Valves shall work equally well with full pressure applied on either side of valve.
  - .8 Approved AWWA C500 gate valves
    - .1 Kennedy C571/F-5065
    - .2 Clow F5000 Series
  - .9 Approved AWWA C509 / C515 resilient seat gate valves
    - .1 Clow R/W F6100 Series
    - .2 Mueller A-2360
    - .3 AVK Series 45 / 65
    - .4 Bibby
    - .5 EJIW
- .2 Valve Boxes
  - .1 Extension pieces must be used for depths greater than 1.9 m.
  - .2 Approved boxes for 1.2 m to 1.65 m depth
    - .1 Bibby VB3000 Series
    - .2 Star Pipe Product VB-5007 Series (30" bottom)
  - .3 Approved boxes for 1.5 m to 1.9 m depth
    - .1 Bibby VB3000 Series
    - .2 Star Pipe Product VB-5007 Series (36" bottom)

## 2.9 Nuts and Bolts

- .1 For flanged joints: to AWWA C207
- .2 For mechanical joints: to AWWA C111/A21.11

## 2.10 U/G Gravity Flow Pipes and Accessories (Sewer and Drainage) to OPSS 410

- .1 Polyvinyl Chloride (PVC)
  - .1 Pipe size, class, material and type shall conform as shown in the contract. The following is an overall list of sewer pipe approved for use on City projects by the Owner for sizes certified by CSA. A substitution from that specified in the contract may be considered in accordance with the General Conditions.
  - .2 Polyvinyl chloride (P.V.C.) pipe - smooth wall (CSA B182.2) - 100mm - 600mm inclusive
    - .1 IPEX
    - .2 Royal

- .3 Northern Pipe – sizes 100mm to 150mm
- .4 Diamond
- .5 National
- .3 Polyvinyl chloride (P.V.C.) pipe – smooth wall (CSA B182.2) – 100mm – 375mm inclusive
  - .1 NEXT Polymers – DURALOC
- .4 Ribbed polyvinyl chloride (P.V.C.) pipe - 200 mm to 600 mm inclusive (CSA B182.4)
  - .1 IPEX
  - .2 Royal Pipe Co. (KOR-FLO) - 200mm to 450mm inclusive
  - .3 RauRib ribbed PVC pipe - 375mm, 450mm, and 600mm

**2.11 Sanitary Forcemain**

- .1 Unless otherwise specified, forcemain test pressure shall be 1030 KPa (150 p.s.i.).
- .2 Fittings shall be suitable for and compatible with the pipe material and class with which they will be used.
- .3 PVC/PVCO pipe 200mm diameter, PVC CSA B137.3 C900 (DR18) or C909 (PVCO) forcemain and fittings, white in colour, pressure rated to 235 psi.
- .4 All pipe to have custom print line to show “Sewage Forcemain”
- .5 Pipe shall have push-on PVC compatible with the pipe and pressures listed, white in colour.
- .6 Blue pipe will not be accepted.
- .7 Mechanical restraints to be supplied as per the table below. Joint restraints to be compatible with the chosen pipe and be as recommended by the pipe manufacturer. All mechanical restraints to be protected from corrosion using the DENSO system or approved equal.
- .8 Joint deflection to be half (1/2) that of the manufacturers recommended joint deflection. Axial deflection of the pipe barrel is not permitted.

**Minimum Length to be Restrained on Each Side of Fittings (m)**

Diameter of Main (mm)	Minimum No. of Steel Rods	11 ¼ deg bend	22 ½ deg bend	45 deg bend	90 deg bend	Dead End
200	2	4	4	4	7	20

**Note:**

- Steel Rods to be a minimum of 20mm in diameter.
- If any joint is encountered in the above restrained length, it must be restrained.
- 5 degree bends with bell and spigot must be restrained at joints.
- Valves are considered dead ends and are to be restrained on each side to the above lengths.

Concrete thrust blocking will not be permitted.

## 2.12 Tracer Wire

- .1 Tracer wire shall be installed on all non-metallic forcemains. The wire shall be install in such a manner as to be able to properly trace all forcemain without loss or deterioration of signal or without the transmitted signal migrating off the tracer wire.
- .2 Tracing wire shall be Direct Burial #12 AWG Solid (.0808" diameter), 21% conductivity annealed copper-clad high carbon steel high strength tracer wire, 452lb average tensile break load, 30 mil. High molecular weight-high density polyethylene jacket (**Green**) complying with ASTM-D-1248, 30-volt rating.
- .3 Approved tracer wire for open cut application:
  - .1 Copperhead 12.30 BHS
  - .2 Pro-Trace HS-CCS PE30
- .4 Approved Direct Bury Connectors:
  - .1 SnakeBite Locking Connector LSC 1230
- .5 For trenchless installations refer to OPSS 450. #12 AWG Solid (.0808" diameter), steel core hard drawn extra high strength horizontal directional drill tracer wire, 1150lb. average tensile break load, 45 mil high molecular weight-high density **Green** polyethylene jacket complying with ASTM-D-1248, 30-volt rating.
- .6 All tracer wire welds onto existing cast of ductile iron pipe shall be completely sealed with the use of Chace/Royston Handy Cap IP. In all cases, the pipe is to be properly cleaned and material shall be applied in accordance with the manufacturer's instructions.
- .7 All splices or repaired wire connections in the tracer wire system shall be made using waterproof connectors specifically rated for underground applications. Tracer wire shall have a Zinc anode installed as per OPSS 442 Table 5.

## 2.13 Pipe Insulation (Buried Rigid)

- .1 In all locations where yard piping is un-insulated and buried with less than 1.2m cover, 50 mm thick rigid insulation shall be installed for frost protection to a total width twice the height above the pipe, plus pipe outside diameter.
- .2 Material used to thermally insulate mains and services shall have a minimum compressive strength of 690 kPa. Approved material is STYROFOAM HI 100 BRAND by Dow Chemical or approved equal

## 2.14 Flexible Self Restrained Transition Couplings

- .1 Refer to drawings for location and size.
- .2 Submit shop drawing and schedule for review.
- .3 On piping systems where a flexible pipe coupling is required for pipe penetration through rigid structures, provide a mechanical joint within 1 meter of the structure
- .4 All pipe with flexible coupling to be self restrained.
- .5 Approved Self Restrained Transition Couplings (or approved equivalent)
  - .1 Smith-Blair model 473 Pipe-Lock, Straight PVC x DI
  - .2 Hymax Grip
  - .3 Robar EBAA 3800 Series Restrained Coupling

## **2.15 Corrosion Protection**

- .1 Material used to electrically insulate connections to steel mains shall be as listed and applied per supplier's recommendation.
- .2 Petrolatum tape systems shall be comprised of three components; paste, mastic and tape and meet the requirements of AWWA C217. Mastic must contain polystyrene beads and paste and tape must be of the same manufacturer as mastic to ensure compatibility. The three components provided shall be manufactured under ISO 9001 standards to ensure consistency of quality of products and substantiating documentation is to be provided upon request.
- .3 All Cast iron (CI) and Ductile Iron (DI) fittings must be installed with a 14.5kg (32lbs) high purity magnesium anode. Anode must be attached to fitting using a CADWELD and coated with mastic (Handy Cap IP). Anodes and installation must meet the requirements of OPSS 442 and be approved by the Contract Administrator.

## **3.0 Execution**

### **3.1 Transporting, Unloading and Storing Pipe**

- .1 The Manufacturer's recommendations govern.
- .2 Take delivery of pipes and fittings at designated storage area or near to trench. Do not impede traffic.
- .3 Remove from site and replace all pipes, specials, fittings and gaskets that are unsound or damaged.
- .4 Unload pipe using mechanical equipment.
- .5 Place materials in safe storage.
- .6 Follow pipe manufacturer's handling and storage recommendations.

### **3.2 Trenching and Backfilling**

- .1 Do trenching and backfilling to Section 02200 and OPSS 410.

### **3.3 Pipe Bedding**

- .1 Granular materials greater than 19mm in size shall not be used for pipe bedding.
- .2 For pipe installed in wet soils stone bedding shall be utilized complete with a geotextile filter cloth wrap.
- .3 Place bedding materials to OPSD 802.010 and 802.030 for all U/G piping unless indicated otherwise on the contract drawings.
- .4 Shape bed true to line and grade, free from sags and high points.
- .5 Shape bedding to cylindrical surface with radius conforming to pipe in accordance with pipe manufacturer's recommendations.
- .6 Place bedding materials simultaneously on each side to spring line of pipe.
- .7 Compact full width of bed to 98% maximum dry density in accordance with Standard Proctor Density.
- .8 Keep pipe joints clear of bedding materials to permit jointing. After jointing is completed, place bedding materials as specified.

- .9 Support pipe on grade and alignment with concrete blocks having minimum compressive strength of 15 MPa when placing concrete bedding.
- .10 Concrete bedding may be placed in two lifts provided:
  - .1 Level of first is not higher than 75mm above bottom of pipe.
  - .2 First lift is cured 24 hours minimum before placing second.
- .11 Prevent movement of pipe during placement of concrete bedding.
- .12 Place bond breaking agent between concrete bedding and sheathing.

### **3.4 Installation of Gravity Pipes**

- .1 Manufacturer's standards govern.
- .2 The Contractor shall supply all labour, equipment and materials required to construct sewers of diameters and in locations indicated on the Contract Drawings.
- .3 The lump sum price shall include excavation, select native backfill, granular bedding, fittings, dewatering, disposal of excess excavation, maintenance of flow, trench liners (if required), utility support, deflection and infiltration / exfiltration testing and traffic control complete as required.

### **3.5 Installing Forcemain**

- .1 The Contractor shall supply all labour, equipment and materials required to install forcemain as shown on the Contract Drawings.
- .2 The lump sum price for forcemain installation shall include, but not be limited to, excavation including disposal of excess material, supply and placement of granular bedding, fittings, and select native backfill, dewatering as required, thrust restraints, corrosion protection as required and all labour, materials, and equipment necessary to install the forcemain. Provide cathodic protection of new forcemain in accordance with manufacturers requirements.
- .3 All suppliers of pipe shall provide an additional visual check of all product before it leaves their facility to certify that it is free of impairments such as cracks, gouges, and chips etc. Reports of all certification checks shall accompany all shipments and be presented to the Engineer.
- .4 The Contractor shall review reports provided by suppliers and visually verify the pipe when received on site to confirm that it is free of impairments such as cracks, gouges, chips etc. Note: Do not install any pipe with noted impairments.
- .5 The Contractor shall provide at least 48 hours notice to all homeowners, businesses, and institutions affected by any disruption including hydro, water, and access etc.
- .6 The Contractor shall exercise caution when working adjacent to existing utilities and shall minimize the length of open trench.
- .7 PVC forcemain pipe shall have minimum and maximum insertion lines on the spigot of every pipe in order to control the homing characteristics. When properly inserted the bell edge should line up between the two insertion lines. If there are no insertion lines on short pieces of pipe the Contractor will be required to mark the pipe by hand. Note: Factory-made assembly lines on the pipe do not indicate correct assembly to fittings.

### **3.6 Placing Cover Material**

- .1 Manufacturers Standards govern.
- .2 Place cover materials from pipe bedding to 300mm above top of pipe and/or according to details indicated on drawings.

- .3 Place cover materials in uniform layers not exceeding 300 mm lift. Compact each layer to 95% maximum dry density in accordance with Standard Proctor Density.
- .4 Provide 300 mm layer of cover material above pipe before using mechanical compactor on top of pipe.

### **3.7 Cutting of Pipe**

- .1 Manufacturers Standards govern.
- .2 Whenever cutting of pipe is required, cut pipes as recommended by pipe manufacturer.
- .3 Method of cutting and cutting equipment to be subject to approval of Engineer.

### **3.8 Shutting Down or Charging Mains**

- .1 During progress of work or at any other time do not shut down, charge any pipes or operate valves unless permission is granted by Engineer.

### **3.9 Connection to Structures**

- .1 Manufacturers Standards govern.
- .2 Provide flexible self restrained couplings within 500mm of outside face of structure as described herein and/or as shown on the drawings.

### **3.10 Cleaning**

- .1 Clean and flush sewers and other underground pipelines.
- .2 Clean all manholes and catch basins of debris.

### **3.11 Forcemain Commissioning (Pressure Test)**

- .1 Forcemains and all other related appurtenances will be commissioned as part of the Contractor's overall commissioning plan. The commissioning will be scheduled so that the forcemain and all other appurtenances can come into service immediately on commissioning of the Sewage Pump Station as directed by the Contract Administrator.
- .2 All work shall be completed in accordance with the Southwest Middlesex Design Standards. In addition, Operations staff from Southwest Middlesex must be present during the commissioning process.
- .3 The Contractor shall supply all labour, material and equipment required to swab and pressure test the new forcemain.

**End of Section**

## 02830 Fences & Gates

### 1.0 General

#### 1.1 Description

- .1 This section specifies requirements for sections of chain link fence to be installed around the site as detailed on the drawings.
- .2 This section also specifies the new gates to be installed.

#### 1.2 Location

- .1 The location of the fence terminal posts and gates is shown on the drawings.

#### 1.3 Quality Assurance

- .1 Fence erection shall be carried out by experienced fence construction personnel.
- .2 Supply materials to OPSS 541.05 and OPSS 1541.

### 2.0 Products

#### 2.1 Fabric Posts

- .1 Fabric height of 1.8 m
- .2 Chain Link fence to be 50 mm x 50 mm “galvanized” steel mesh.
- .3 Wire to be 3.76 mm diameter galvanized steel conforming to ASTM-A817.

#### 2.2 Wire

- .1 Tension wire – 5 mm galvanized
- .2 Barbed wire – ASTM-A121 galvanized with 4-point barbs at 150mm spacing. Wire thickness to be 2.49mm minimum.

#### 2.3 Posts and Rails

- .1 Terminal posts, line posts, braces and rails to ASTM-A53.
- .2 Line Posts - 60 mm O.D. c/w tops.
- .3 Terminal Posts - for ends, gates and corners - 90 mm with gate posts as specified in Article 2.5.
- .4 Top Rail - 45 mm O.D. standard galvanized pipe.
- .5 Bracing - 45 mm O.D. standard galvanized pipe.
- .6 Post height to be suitable for hole depths specified and barbed wire overhang

## 2.4 Fittings

- .1 Top rail ends, brace bands, tension bars, arms, top, sleeves, hinges and latches in accordance with frost fence details.
- .2 All fittings to be hot dipped galvanized or cast aluminum.
- .3 Terminal and gate posts to have dome tops.
- .4 Fasteners – 5 mm aluminum or 3 mm steel.
- .5 Stretcher Bars – min 5 x 20 steel.

## 2.5 Gates

- .1 Supply and install gates to OPSS 1541 and OPSD 972.102, widths as noted on the drawings.

## 2.6 Concrete

- .1 Compressive strength 20 MPa at 28 days.
- .2 Use type 50 sulphate resistant cement.

## 3.0 Execution

### 3.1 General

- .1 Install fence to OPSD 972 and OPSS 772.

### 3.2 Grading

- .1 Remove debris and grade between posts to provide ground clearance between 40 mm and 70 mm.

### 3.3 Post Setting

- .1 Line post holes to be 1060 mm deep, 250 mm diameter.
- .2 Terminal post holes to be 1220 mm deep, 300 mm diameter.
- .3 Line posts to be spaced maximum 3.0 m.
- .4 Set posts in line and plumb so that the fence forms a straight line between corner posts.
- .5 Set posts in concrete and extend concrete above grade for drainage.
- .6 Install straining posts where required.

### 3.4 Fence Erection

- .1 Allow concrete to cure sufficiently before erecting fence - minimum 5 days.
- .2 Set braces between end posts, gate posts and line posts.

- .3 Set fittings in place and stretch fabric in place.
- .4 Install top rail and fasten to posts with caps.
- .5 Secure fabric with tie wires at 450 mm intervals.

### **3.5 Cleanup**

- .1 Touch up damaged galvanized by cleaning with a wire brush and applying two (2) coats of touch up paint for galvanized metal.
- .2 Clean up debris and earth removed from posts holes and trim areas disturbed.

### **3.6 Installation**

- .1 Install gates in accordance with manufacturer's printed instructions and under supervision of manufacturer's representative.
- .2 Install wiring and conduits and make all connections.

**End of Section**

## 02930 Lawns Grass

### 1.0 General

#### 1.1 Description

- .1 Supplying and placing topsoil and seed and mulching for restoration of areas disturbed or damaged by construction.

#### 1.2 Related Work Specified Elsewhere

- .1 Section 02210 Grading
- .2 Section 02980 Restoration

### 2.0 Products

#### 2.1 Topsoil

- .1 On Site Topsoil:
  - .1 Use topsoil free from vegetation, subsoil, gravel, sand or other extraneous materials and free from stones, clods or clumps over 50 mm dia.
  - .2 As approved by Contract Administrator.
- .2 Imported Topsoil:
  - .1 Fertile, friable, natural loam containing not less than 5% organic matter.
  - .2 Organic matter not greater than 30% after addition of soil amendments.
  - .3 Free of stones, subsoil, refuse or other extraneous material.
  - .4 Capable of sustaining healthy plant growth.
  - .5 Do not use topsoil in frozen or muddy condition.
  - .6 Topsoil subject to approval of Contract Administrator.

#### 2.2 Seed to OPSS 572

- .1 Use Seed Type I.
- .2 Nurse crop seed for seeding and mulching operations to be of best quality, free from disease, weed seeds or other foreign matter and of species indicated by following:
  - .1 Straw Mulch - Fall Wheat or Rye Grain.
  - .2 Hydraulic Mulches - Italian (Annual) Rye grass.
  - .3 Only seeds harvested in preceding season will be accepted.

#### 2.3 Hydroseed

- .1 Use Flexterra – Flexible Growth Medium (FGM).
- .2 Unsuccessful seed growth will prompt additional topsoil and hydroseed application at the expense of the Contractor.

## **2.4 Fertilizer**

- .1 Commercial fertilizer containing following percentage by weight:
  - .1 Nitrogen 10%
  - .2 Phosphoric Acid 10%
  - .3 Potash 10%
- .2 Fertilizer for seeding and mulching shall be a standard 9-32-16 analysis in granular form.
- .3 Transport to site in weatherproof bags showing weight, analysis and manufacturer's name.

## **3.0 Execution**

### **3.1 Surface Preparation**

- .1 Grade areas to receive topsoil to uniform surface.
- .2 Eliminate uneven areas and low spots, ensuring positive drainage. Do not fill depressions with topsoil.
- .3 Remove debris, rocks, vegetation, stones and other coarse matter.
- .4 Remove subsoil that is contaminated with oil, fuels or solvents.
- .5 Dispose of removed materials as directed.

### **3.2 Placing Topsoil**

- .1 Start placing of topsoil only after building, structures, roadways, sidewalks and parking areas have been completed.
- .2 Place topsoil to minimum thickness of 100 mm.
- .3 Do not place topsoil on frozen or wet surfaces or when topsoil is in wet muddy, extremely dry or frozen condition.
- .4 Rough grade topsoil to required lines and contours then harrow.
- .5 Loosen entire area to depth of 25 mm.
- .6 Rake and remove all debris, roots, vegetation and stones larger than 50 mm in size.

### **3.3 Finish Grading**

- .1 Fine grade entire topsoiled area to contours and elevations specified or as directed by Contract Administrator. Eliminate rough spots and low areas ensuring positive drainage.
- .2 Leave surface smooth, uniform, firm against deep foot printing, with fine loose texture.
- .3 Grade areas along property lines to meet existing grade levels.

### **3.4 Application of Fertilizer**

- .1 Apply 10-10-10 fertilizer to prepared area prior to seeding or sodding.
- .2 Spread fertilizer to entire area at rate of 10kg per 100 square metres.

### **3.5 Sodding**

- .1 Do not lay sod on extremely dry, frozen or excessively wet soil.

- .2 Lay sod in rows at right angles to slopes, smooth, even with adjoining areas and with joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections. Tearing of sod is not permitted.
- .3 Roll sod lightly with a roller weighing between 70 and 115 kg. Roll in two directions perpendicular to each other.
- .4 Water immediately after sod laying and obtain moisture penetration through sod into topsoil. Maintain sod until growth is established.

**End of Section**

## 02980 Restoration

### 1.0 General

#### 1.1 Scope and General Requirements

- .1 Furnish all labour, plans, equipment and materials to restore all public and private property to its former condition upon completion of construction.
- .2 Pay all applicable costs or charges by any authority having jurisdiction for restoration and reinstatement of roads, utilities, etc.
- .3 Include the cost of all restoration in the total tender price.

#### 1.2 Restoration of Trees, Shrubs and Bushes

- .1 Do not remove any tree, shrub or bush unless required under the Contract or upon written instruction of the Contract Administrator.
- .2 Replace all trees, shrubs or bushes accidentally or wilfully removed with equal quality nursery stock of approximately the same age and size. Maintain replaced items for a period of two (2) years.
- .3 Preserve shrubs and bushes for transplanting in new locations where required by the Contract Administrator.

#### 1.3 General Restoration and Rehabilitation

- .1 Restore all signs, fences, light standards, posts and any other item destroyed or removed during the course of the work.
- .2 Restore all walkways, parking, shoulders, curbs, sidewalks, gutters, drainage systems, pipes, hydrants, valves, chambers, manholes, catch basins and any structure damaged or destroyed during the course of the work.
- .3 Restore or pay for the restoration of all utilities, cables, poles, lines, wires, conduits or pipes damaged or destroyed during the course of the work. Restore or pay for the restoration of any building or structure damaged during the course of the work.
- .4 Remove all signs, debris, materials, plant and equipment from the site.

**End of Section**

**DIVISION 3  
CONCRETE**

## **Division 3 Concrete - Index**

*03000 General*

*03100 Concrete Formwork and Falsework*

*03200 Concrete Reinforcement*

*03250 Concrete Accessories*

*03300 Cast-In-Place Concrete*

*03480 Precast Concrete Specialties*

*03610 Grout and Miscellaneous Concrete Work*

**End of Section**

## **03000 GENERAL**

### **1.0 General**

#### **1.1 Order of Priority**

- .1 The instructions given in this Section are to be given precedence with regard to Contract interpretation over the following sections within this Division.
- .2 Notwithstanding clause 1.1.1 above, instructions given Division 1 – General Requirements are to be given precedence with regard to Contract interpretation over those in this Division.

#### **1.2 Intent of Specifications**

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.2.2 of this Section at no additional cost to the Owner except as allowed in the sole discretion of the Engineer.

#### **1.3 Engineer and Contract Administrator**

- .1 In this Division, Engineer and Contract Administrator are deemed to have the same meaning.
- .2 The Engineer is as defined in the General Conditions section of this Contract.

#### **1.4 Submission of Alternate Proposals for Products or Materials**

- .1 If the Contractor requests use of an alternate product or material then he/she is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract.
- .2 If an alternative product or material is accepted for use then the Contractor is responsible at his/her cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .3 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.

#### **1.5 References to Standards**

- .1 If references to standards appear in this Division, it is the intention of these Specifications to refer to the standard that was in effect at the time of the tender close for this Contract regardless of the date or version of the standard stated in the Division.

**END OF SECTION**

## 03100 CONCRETE FORMWORK AND FALSEWORK

### 1.0 General

#### 1.1 Summary

- .1 Comply with Division 1: General Requirements.
- .2 This Section forms part of Section 03300: Cast In Place Concrete.

#### 1.2 References

- .1 CSA A23.1 Concrete Materials and Methods of Concrete Construction.
- .2 CSA S269.1 Falsework for Construction Purposes.
- .3 CAN/CSA S269.2 M Access Scaffolding for Construction Purposes.
- .4 CAN/CSA S269.3 M Concrete Formwork.
- .5 NLGA Standard Grading Rules for Canadian Lumber.
- .6 CAN/CSA-G40.21 – Structural Quality Steel.
- .7 CSA-S157 – Strength Design in Aluminum.
- .8 OPSS 919 Formwork and Falsework.
- .9 The Occupational Health and Safety Act and Regulations for Construction Projects of Ontario.

#### 1.3 Design Requirements

- .1 Comply with requirements of CSA S269.1, CAN/CSA S269.2 M, and CAN/CSA S269.3 M, except as noted.
- .2 Design formwork and falsework to carry dead loads and construction live loads.
- .3 Where high slump concrete is used, design formwork and falsework for full hydrostatic pressure.
- .4 Limit deflections of formwork to tolerance limits in accordance with CAN/CSA-S269.3-M, Clause 6.6 - Deflection.
  - .1 Failure of formwork and falsework due to improper design and/or construction to satisfactorily support concrete and all loads superimposed by construction operations to be remedied by Contractor at no extra cost.

#### 1.4 Submittals

- .1 Samples (Not Applicable)
  - .1 Submit samples of form ties and Controlled Permeability form Liner.
- .2 Product Data Sheets
  - .1 Submit three copies of manufacturer's product data sheets if requested by Owner or Engineer including installation, application, and maintenance instructions for:
    - .1 Lumber for formwork and falsework.
    - .2 Plywood for formwork and falsework.
    - .3 Formwork for curved surfaces.

- .4 Tubular column forms.
- .5 Prefabricated forms.
- .6 Form release agent.
- .7 Form ties.
- .3 Shop Drawings
  - .1 Submit shop drawings of formwork and falsework bearing seal and signature of a professional engineer for record purposes at least 4 weeks before construction is commenced.
  - .2 Formwork and falsework drawings will not be reviewed for structural adequacy.
  - .3 Be fully responsible for the design, construction, and maintenance of formwork and falsework.
    - .1 Show design criteria as specified in clause 6.5.2 Drawing for Formwork CSA A23.1-09.
  - .4 Submit manufacturer's literature on proprietary scaffolding, shoring beams, formwork and similar items, giving details of materials, methods of use, and allowable loading.
  - .5 Two unstamped copies of the shop drawings will be returned with Engineer's comments.

## 1.5 Quality Assurance

- .6 Professional Engineer licensed in the Province of Ontario and retained by Contractor is to design, supervise installation, and inspect and certify the erected formwork and falsework.
- .7 Provide product manufacturer's representative at site for installation assistance, including control permeability form liner.

## 2.0 PRODUCTS

### 2.1 Materials

- .1 Lumber for formwork and falsework: Grade marked sawn lumber graded in accordance with NLGA.
- .2 Plywood for formwork: CSA A23.1; high density overlay (plastic overlay) grade plywood.
- .3 Formwork for curved surfaces: Fibreglass or metal forms which will produce surface finishes specified.
- .4 Tubular column forms: Round, spirally wound, laminated fibre forms, internally treated with release agent.
- .5 Structural steel shall conform to CAN/CSA G40.20 and G40.21 and be of the grade shown on the stamped working drawing. Steel forms shall give a smooth, plain finished surface to the work.
- .6 Aluminum shall conform to CSA – S157 and be of the alloy and temper shown on the stamped working drawing.
- .7 Form release agent: Flashpoint 40°C minimum; freezing point 15°C maximum; does not leave a residue, discolouration, or stain concrete surface; compatible with permanent finish coating where applicable:
  - .1 RICH COTE by NCA/Acrow Richmond Ltd.
  - .2 Sealtight Duogard by W.R. Meadows of Canada Ltd.

- .3 Eucoslip VOX by Euclid Admixture Canada, Inc.
  
- .8 Form Ties
  - .1 Liquid holding structures and exterior walls below grade: Coil type with force fit waterstop disc or integral waterstop, and setback plastic cone that leaves a 25mm deep hole in concrete surface.
  - .2 Other structures: Removable, tapered, or snap off type of fixed or adjustable length with setback plastic cone that leaves a 25mm minimum deep hole in concrete surface.

### **3.0 EXECUTION**

#### **3.1 Preparation**

- .1 Remove water, snow, ice, loose soil, laitance, curing compound, wood, leaves, and other debris and clean formwork surfaces before placing concrete.

#### **3.2 Erection of Formwork**

- .1 General
  - .1 Construct formwork in accordance with CAN/CSA S269.3 M so that finished concrete will comply to shape, dimensions, tolerances, and surface finish specified.
  - .2 Provide lines, levels, and arrangement of parts before erecting formwork.
  - .3 Comply to tolerances of CSA A23.1, Clause 6.4 Construction Tolerances for Cast In Place Concrete.
  - .4 Align form joints and make watertight. Keep number of joints to a minimum.
  - .5 Laterally brace formwork and falsework and prevent displacement during concrete placement.
  - .6 Construct 20mm chamfers at exposed edges.
  - .7 Form chases, openings, projections, recesses, expansion joints, and construction joints.
  - .8 Form around pipes, mechanical, and electrical equipment which penetrate the concrete structure.
  - .9 Incorporate frames, castings, pipes, sleeves, and similar items in formwork.
  - .10 Do not re use damaged formwork which may not provide a uniformly consistent finish.
  - .11 Do not use wire ties through exposed surfaces.
  - .12 Do not use internal ties through curb or sidewalk, which could be constructed using combinations of clamps and removable struts.
- .2 Fasteners
  - .1 Use only galvanized nails and fasteners when such fasteners will be left in place in the permanent structure.
- .3 Form Ties
  - .1 Install form ties to maintain proper dimensional and clearance tolerances.

- .2 Do not use through the wall removable form ties for walls of liquid holding structures and exterior walls below grade.
- .3 Where excavation shoring system is used as formwork, fasten form tie to shoring in a suitable manner to withstand applied loads.
- .4 Formwork with Liner (Not Applicable)
  - .1 Assemble formwork with liner so that there is continuity in texture and pattern from panel to panel and joints between panels are not visible in concrete unless the pattern requires it.
  - .2 Obtain acceptance of assembly before placing concrete.
  - .3 Provide liner on the interior face of all BAF cells only.
  - .4 Provide liners with full sheets and place seams at horizontal and vertical grooves. Prepare as recommended by the manufacturer.
  - .5 Use anchorage systems recommended by the manufacturer to anchor liner to formwork.
  - .6 Do not use form release agent on formwork.
- .5 Shoring Under Walls or Columns
  - .1 When constructing concrete walls or columns on top of slabs or beams, provide shoring under these slabs or beams to carry the total construction load.
  - .2 Leave shoring in place until the compressive strength of the concrete in the wall above has reached 75% of its 28-day compressive strength.
- .6 Lateral Supports
  - .1 Where required, brace walls until permanent lateral supports are in place.
- .7 Formwork at Construction and Expansion Joints
  - .1 Provide formwork incorporating waterstop in joint.

### **3.3 Removal of Formwork**

- .1 General
  - .1 Remove formwork as soon as possible after concrete has attained adequate strength to support its own weight and superimposed loads, without cracking or deflecting excessively in order to facilitate effective finishing, but not earlier than 30 hours after placement.
  - .2 Remove nails, fasteners, and tie wire at the surface.
- .2 Slabs and Columns
  - .1 Remove formwork for slabs and columns after concrete has reached 75% of its specified 28-day compressive strength.

**END OF SECTION**

## 03200 Concrete Reinforcement

### 1 GENERAL

#### 1.1 Summary

- .1 Comply with Division 1 General Requirements.
- .2 This Section forms part of Section 03300 - Cast In Place Concrete.
- .3 Products supplied but not installed under the work of this section
  - .1 Reinforcing bars for grouted-in dowels.

#### 1.2 Related Sections

- .1 Section 01300: Submittals

#### 1.3 References

- .1 CSA A23.1 Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.3 Design of Concrete Structures.
- .3 CSA G30.5 M Welded Steel Wire Fabric for Concrete Reinforcement.
- .4 CAN/CSA G30.18 Billet Steel Bars for Concrete Reinforcement.
- .5 CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures.
- .6 CSA W186 M Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .7 OPSS1442 Material Specification for Epoxy Coated Steel Reinforcement (Concrete).

#### 1.4 Submittals

- .1 Shop Drawings
  - .1 Reinforcing Bars
    - .1 Submit reinforcing bar placement drawings prepared in accordance with Reinforcement Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada and as specified below.
    - .2 Indicate reinforcing bars that form part of an individual concrete placement and reinforcing bars that extends into adjacent placements.
    - .3 For each reinforcing bar placement shop drawing, submit a separate bar list and bending schedule showing size, shape, dimensions, and numbers of bars required for each bar type.
    - .4 Identify reinforcing bars in the bar list and bending schedule with a separate bar mark that corresponds to bar marks shown on reinforcing bar placement drawings.
    - .5 If bar list and bending schedule contain details of bars of more than one reinforcing bar placement drawing, then arrange bar marks in separate groups for each placement drawing. Clearly indicate for each bar mark the corresponding reinforcing bar placement drawing number.
    - .6 For slabs, show a separate plan indicating concrete thicknesses, reinforcing bars, and dowels for walls and columns cast in slab.

- .7 For walls, show separate elevations indicating concrete thicknesses, reinforcing bars, and dowels for slabs and adjacent walls cast in wall.
  - .8 Do not add new information on previously reviewed shop drawings.
  - .9 Placing drawings to show locations of all construction joints indicated on the Drawings and as required by the Contractor.
  - .10 Review of bar lists and placing drawings by the Engineer will be for general compliance with design and will not signify complete checking of bending and cutting details or numbers of bars. No claim for extra payment will be entertained which results from any errors in the bar lists and placing drawings.
- .2 Submit shop drawings of dowel bar splicers detailing locations, size, and type.
- .2 Source Quality Control Submittals
    - .1 Submit certified mill test reports of steel reinforcing bars if required by Engineer.

## **1.5 Delivery, Storage and Handling**

- .1 Ship bundles of reinforcing bars identified by tags containing bar marks along with bar list.
- .2 Store materials in a manner, which will prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.

## **2 PRODUCTS**

### **2.1 Materials**

- .1 Reinforcing Bars
  - .1 Deformed steel bars: CAN/CSA G30.18 Grade 400W. Do not substitute with epoxy-coated bars.
- .2 Chairs, Bolsters, Bar Supports, and Side Form Spacers
  - .1 Adequate for accurate placing and as required for construction loads. Provide nonconductive bar supports in contact with exposed surfaces that prevents moisture movement from the surface to the reinforcement.
  - .2 Plastic, precast concrete or stainless steel units for concrete surfaces exposed to view or to moisture. For plastic or stainless steel chairs exposed to view, the exposed surface not to exceed 300mm<sup>2</sup>.
  - .3 Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports are not high enough.

### **2.2 Fabrication**

- .1 Reinforcing Bars
  - .1 Comply with CSA A23.1 and CSA A23.3.
  - .2 RSIC Manual of Standard Practice.
  - .3 Tolerances:
    - .1 Length:  $\pm 25$ mm.
    - .2 Height of truss bar: +0 to 10mm.
    - .3 Outside dimensions of stirrups, ties, and spirals:  $\pm 10$ mm.

- .4 Other bends:  $\pm 25\text{mm}$ .
  - .5 Use longest bar possible. Keep number of splices to a minimum.
  - .6 Do not weld chairs, bolsters, bar supports, or spacers to reinforcing bars.
- .2 Reinforcing Splices
- .1 Lap Splices
    - .1 Splice by lapping reinforcing bars, unless specified otherwise.
    - .2 Use Class B lap splice length for continuous reinforcement, unless noted otherwise.
    - .3 Stagger splices in adjacent horizontal bars, including splices at construction joints by 1500mm minimum.
    - .4 Provide splice length for horizontal reinforcing bars in walls as provided for top bars.
  - .2 Welded Splices
    - .1 Full penetration direct butt splice welds in accordance with CSA W186 M and as specified.
- 2.3 Source Quality Control**
- .1 Mill tests: Determine physical and chemical properties of steel reinforcing in accordance with requirements of CAN/CSA-G30.18
- 3 EXECUTION**
- 3.1 Preparation**
- .1 Deliver, store and handle all materials in a manner which prevents contamination from bond reducing or foreign matter and damage to its fabricated form.
  - .2 Clean reinforcing bars of loose rust, mill scale, dried cement paste, mud, oil, or other coatings that will affect adhesion in accordance with CSA A23.1, Clause 6.1.5 - Surface Conditions of Reinforcement, prior to placing concrete.
- 3.2 Installation**
- .1 General
    - .1 Fabricate and place reinforcement to clause 6 –CSA A23.1-09.
    - .2 Provide required concrete cover. Ensure a minimum of 40mm cover for tie wires, form ties bolts etc. for concrete surfaces in contact with water. Do not let reinforcing tie wire touch formwork or be exposed in the finished concrete structure.
    - .3 Do not place concrete until reinforcing bar placement is reviewed by the Contract Administrator.
    - .4 Do not rebend reinforcing bars.
  - .2 At Construction Joints
    - .1 Continue regular reinforcing bars through construction joints.

- .3 At Openings in Walls and Slabs
  - .1 Add reinforcing bars on each side of openings, extending a Class B lap splice length beyond the opening at each side, equivalent to half the total area of reinforcing cut or disrupted, unless noted otherwise.
- .4 Tying
  - .1 Tie bars at the lesser of every fourth intersection or 1000mm.
- .5 Field Bending and Welding:
  - .1 Field bending is not permitted without prior review by the Engineer. When authorized by the Engineer, field bend reinforcement without heat and slowly with a steady even pressure to a minimum radius of 4 bars diameters.
  - .2 Welding of reinforcement will not be allowed without prior review by the Engineer.
- .6 Splices
  - .1 Provide contact lap splices for all spliced bars.
- .7 Cleaning
  - .1 Remove all deleterious materials in contact with the reinforcement.

### 3.3 Concrete Cover

- .1 In accordance with the following schedule except as may be modified or noted on Drawings:

	Minimum Cover (mm)
.1 Cast against and permanently exposed to earth.	75
.1 All other locations	60

### 3.4 Inspection and Approval

- .1 Do not order concrete until the reinforcement has been inspected and approved by the Engineer.

**END OF SECTION**

## 03250 Concrete Accessories

### 1 GENERAL

#### 1.1 Summary

- .1 Comply with Division 1 General Requirements.
- .2 This Section forms part of Section 03300 - Cast In Place Concrete.
- .3 Products installed but not supplied under the work of this Section
  - .1 Location and installation affect the work of this Section. List is not guaranteed as being complete.
    - .1 Anchor bolts.
    - .2 Electrical conduits.
    - .3 Frames for covers and openings.
    - .4 Equipment castings and pipe fittings.
    - .5 Embedded plates with anchors.

#### 1.2 Related Work Specified Elsewhere

- .1 Section 01300: Submittals

#### 1.3 References

- .1 CSA A23.1 Concrete Materials and Methods of Concrete Construction.
- .2 CAN/CSA G40.21 Structural Quality Steels.
- .3 CAN/CSA-G164 Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 CGSB 71-GP-24M Adhesive, Flexible, for Bonding Cellular Polystyrene Insulation.
- .5 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60 000 psi Tensile Strength.
- .6 ASTM A780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

#### 1.4 Submittals

- .1 Samples
  - .1 Joint fillers.
  - .2 Hydrophilic waterstop.
- .2 Product Data Sheets
  - .1 Submit three copies of manufacturer's product data sheets including installation, application, and maintenance instructions for:
    - .1 Foamed PVC joint filler.
    - .2 Preformed joint filler.
    - .3 Hydrophilic waterstop.
- .3 Shop Drawings
  - .1 Expansion and Construction Joints
    - .1 Submit shop drawings of joints.

- .4 Certificates
  - .1 Submit certification of compliance for hot-dip galvanizing in accordance with CAN/CSA-G164.

## 1.5 Quality Assurance

- .1 Engage manufacturer's representative for on-site supervision during and after installation. Verify that specified products are correctly installed and comply with manufacturer's printed instructions.

## 2 PRODUCTS

### 2.1 Materials

- .1 Foamed PVC joint filler: Closed cell, non-extruding polyvinyl chloride (PVC) foam; Rodofam, Sealtight Rescor Type S by W.R. Meadows Ltd.
- .2 Adhesive for expansion joint filler: CGSB 71-GP-24M, Type II; 230-21 Rigid Insulation Adhesive by Bakor Inc.
- .3 Adhesive Anchors
  - .1 Adhesive anchoring system as manufactured by the following companies:
    - .1 Hilti Canada - HY200 System
    - .2 Powers Industries - AC100 Plus System
    - .3 Meadows Canada - Rezi-Weld Gel Paste State
    - .4 Sika Canada - Sikadur Injection Gel
- .4 Chemical Anchors
  - .1 Hilti "HVA" adhesive anchor, Powers' Rawl "Chem-Stud", or Ucan adhesive anchors at locations as indicated on Drawings. All threaded bars shall be Type 304 stainless steel.
- .5 Bond breaker: Polyethylene tape, or coated paper.
- .6 Hydrophilic Waterstop:
  - .1 Adeka Ultra Seal as manufactured by Asahi Denka Kogyo K.K.
  - .2 MC-2010MN for wall/slab thickness greater than 9 in. (229 mm) with minimum 4 in. (102 mm) concrete cover.
  - .3 KBA-1510FP for wall/slab thickness greater than 4 in. (102 mm) with minimum 1 in. (25 mm) concrete cover.

## 3 EXECUTION

### 3.1 Preparation

- .1 Preparation of Joints
  - .1 Prepare joints in accordance with requirements of this Section.

### 3.2 Installation

- .1 Construction Joints
  - .1 General
    - .1 Construction joints in addition to those indicated on the Drawings may be required to execute the work in accordance with concrete placing schedule. Provide such construction joints without extra compensation.

- .2 Prepare surface of concrete in accordance with clause 7.3.1 - CSA A23.1-09 Construction Joints to produce a bonded concrete joint.
- .3 Form standard keys at construction joints where shown. Make keys 40mm deep by one third of member thickness, unless noted otherwise.
- .4 Roughen face of construction joint immediately upon removal of formwork.
- .5 Make provisions of materials, and labour for an unscheduled interruption during a concrete placing operation. Supply and place such materials and make the construction joint satisfactory without extra compensation.
- .2 Installation of Hydrophilic Waterstops in Construction Joints
  - .1 Install waterstops in strict accordance with manufacturer's printed specifications and recommendations.
  - .2 Installation shall not proceed when work areas are flooded to the extent that would cause hydrophilic waterstop to hydrate; nor when precipitation can be responsibly anticipated before hydrophilic waterstop can be properly installed or protected.
  - .3 Clean all debris, dirt and rocks from dry concrete surface. Concrete to be free of large voids and projections.
  - .4 Apply adhesive, 3M-2141 bonding agent to prepared concrete surface and allow to set approximately 15 minutes or until tacky.
  - .5 Press the entire length of hydrophilic waterstop firmly against primed surface. Verify minimum concrete coverage will be maintained over entire placement of waterstop. Place in maximum practicable lengths to minimize coil and joints.
  - .6 Overlap ends a minimum 50 mm when joining.
  - .7 When working with wet concrete, nail hydrophilic waterstop in place using concrete nails placed 250-300 mm apart.
  - .8 Pour and vibrate concrete. Whenever possible do not pour concrete directly on waterstop or allow vibrator to come in direct contact with waterstop.
  - .9 Provide and install waterstops at construction joints as indicated on Drawings.
- .2 Mechanical Connectors
  - .1 To be installed as per manufacturers recommendations.
- .3 Setting Anchor Bolts for Equipment, Fittings and Structural Steel.
  - .1 Receive, handle, and set anchor bolts in accordance with the requirements of the trade supplying them. Protect anchor bolts after setting to maintain correct alignment and level.
- .4 Electrical Conduits in Slabs and Walls
  - .1 Install conduits where required in slabs and walls in accordance with requirements of CSA A23.1, Clause 6.7.5 - Conduits and Pipes Embedded in Concrete.
  - .2 Use of aluminum conduits is not permitted.
- .5 Frames for Covers and Openings
  - .1 Set frames at locations and required elevations.

- .6 Equipment Castings and Pipe Fittings
  - .1 Set castings and pipe fittings at locations and elevations required.
- .7 Repair hot-dip galvanized surfaces 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 to exceed original coating thickness by 25% minimum.

**END OF SECTION**

## 03300 Cast In Place Concrete

### 1 GENERAL

#### 1.1 Summary

- .1 Comply with Division 1 General Requirements.
- .2 Comply with requirements of CSA 23.1/.2, except where noted otherwise in this Specification.
- .3 The following sections form part of this Section:
  - .1 Sections 03100: Concrete Formwork and Falsework
  - .2 Section 03200: Concrete Reinforcement
  - .3 Section 03250: Concrete Accessories
  - .4 Section 03345: Concrete Finishing
  - .5 Section 03610: Grout and Miscellaneous Concrete Work.
- .4 Do not use materials that are toxic in installed condition. Do not use volatile organic compounds where not permitted by law. Where uses of volatile organic compounds are permitted, provide adequate ventilation and take necessary safety precautions.
- .5 Section Includes
  - .1 Normal density concrete.
  - .2 Fill concrete.
  - .3 Repair of cracks that develop in concrete.

#### 1.2 References

- .1 CSA A23.1 Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.2 Test Methods and Standard Practices for Concrete.
- .3 CSA A23.3 Design of Concrete Structures.
- .4 CSA A3001 Cementitious Materials for use in Concrete.
- .5 CSA A3002 Masonry and Mortar Cement.
- .6 CSA A3003 Chemical Test Method for Cementitious Materials use in Concrete and Masonry.
- .7 CSA A3004 Physical Test Method for use in Concrete and Masonry.
- .8 CSA A3005 Test Equipment and Materials for Cementitious Materials for use in Concrete and Masonry.
- .9 ACI 304.2R Placing Concrete by Pumping Methods.
- .10 ASTM C260 Specifications for Air-Entraining Admixtures for Concrete.
- .11 ASTM C494 Specification for Chemical Admixtures for Concrete.
- .12 ASTM C900 Test Method for Pullout Strength of Hardened Concrete.
- .13 ASTM C1017 Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

- .14 ASTM C1074 Practice for Estimating Concrete Strength by the Maturity Method.

### 1.3 Performance Requirements

- .1 28-day Concrete Compressive Strengths
  - .1 Normal density concrete:
    - .1 Type A: 35 MPa
    - .2 Type B: 20 MPa
    - .3 Type C: 15 MPa
  - .2 Density
    - .1 Normal density.
  - .3 Construction Tolerances
    - .1 Comply with Clause 6.4 –CSA A23.1-14 unless noted otherwise.

### 1.4 Summary

- .1 Product Data Sheets
  - .1 Submit three copies of manufacturer's product data sheets including installation, application, and maintenance instructions for:
    - .1 Chemical admixtures.
- .2 Concrete Mix Design
  - .1 Submit proposed performance mix, and supplier's applicable standard deviations.
  - .2 Tabulate concrete mixes. Indicate range of cementing materials content, type of cements, size of coarse aggregate, water/cementing material ratio, admixtures used, air content, slump, and locations of use for each mix.
  - .3 For high slump flowing concrete submit a mix that will not result in segregation.
  - .4 Submit proposed method(s) of controlling concrete temperatures when placing in cold and hot weather to meet requirements of this Section.
  - .5 Concrete mix designs will be reviewed for conformance with requirements of the Specifications and will be returned with Engineer's comments.
- .3 Source Quality Control Submittals
  - .1 Provide certification that source for fine and coarse aggregates are not subject to deleterious expansion.
  - .2 Chemical admixtures, used in the production of concrete for potable water structures, shall be certified as safe product from recognized approving authorities.
  - .3 Submit certification that the cement and supplementary cementing materials do not contain large amounts of regulated metals and no hazardous waste derived fuels were used in the production of the cement(s).
- .4 Quality Control Submittals
  - .1 Submit Concrete quality control plan for the project. Provide the following:
    - .1 Certification from concrete producer that a professional engineer has designed the mix based on the requirements of the Specification and that concrete mix will meet the performance requirements.

- .2 Identify the Company and contact names of subcontractors, material suppliers and testing companies involved with concrete manufacture and placement.
- .3 Identify concrete requirements for each element of the project.
- .4 Identify all tests that will be used for material acceptance and indicate minimum specification requirements for each test.
- .5 Identify the frequency of testing for each test.
- .6 Identify the course of action to be taken if the testing program indicates that specification requirements have not been met.
- .7 Concrete quality control plan shall not take precedence over any other Contract documents.
- .2 Submit concrete delivery records.
- .5 Concrete Placing Schedule
  - .1 Submit concrete placing schedule.
- .6 Certificates
  - .1 Submit certificate of Ready Mixed Concrete Production Facilities.
  - .2 Submit certification that aggregates will not, nor have the potential to, react with cement to result in deleterious expansion in the concrete.
  - .3 Submit certification that deleterious substances in aggregate are within limits specified in CSA A23.1, Table 12 Limits for Deleterious Substances and Physical Properties of Aggregates.
  - .4 Submit certification that proposed performance mix will produce concrete meeting the requirements of Specifications.
  - .5 Submit certification that proposed mix design strengths have been selected allowing for the supplier's standard deviations as indicated in CSA A23.1, Clause 4.4.6 Compressive Strength.
  - .6 Submit certification that bonding agent, if used, will meet the requirements of Specifications.

## 1.5 Quality Assurance

- .1 Ready Mixed Concrete Producer: Certified member in good standing of the local Ready Mixed Concrete Association.
- .2 Concrete Testing
  - .1 Testing of concrete for materials and compression will be done by agencies paid for by the Owner.
  - .2 Pay for additional testing required because of changes in material or the mix proportions, as well as any extra testing of concrete or materials occasioned by their failure to meet the specification requirements.
  - .3 The use of testing services does not relieve the Contractor of their responsibility to provide materials and construction in compliance with the Drawings and Specifications.

## 1.6 Delivery, Storage and Handling

- .1 Comply with manufacturers' recommendations for delivery, storage, and handling.
- .2 Store materials in a manner that will prevent deterioration or contamination. Deteriorated or contaminated materials will be rejected and must be removed from site.

**1.7 Site Condition**

- .1 Cold Weather Requirements
  - .1 The following requirements are in addition to CSA A23.1, Clause 7.1.2 – Cold Weather Concreting.
  - .2 Provide temperature-controlled enclosures for areas where concrete is placed whenever ambient air temperature is 5°C or lower.
  - .3 Protect concrete from the adverse effects of space-heated enclosures including local overheating and combustion products.
  - .4 Heat mix water and, if necessary, aggregates when air temperature is at or below, or predicted to go below, 5°C at any time during the next 24 hours.
  - .5 Maintain temperature of reinforcing bars and forms above 10°C prior to placing concrete.
  - .6 Maintain temperature of concrete when deposited in forms not less than 15°C and higher than 25°C.
  - .7 Maintain temperature of concrete at surfaces at least 10°C for a minimum period of seven days after placing and achieving minimum 75% of specified strength. Concrete temperature may then be lowered to ambient air temperature at a rate of 1/2°C per hour or 10°C per day.
  - .8 Use additional protection if full 28-day compressive strength is required at an early age.
  - .9 Keep concrete continuously moist during the curing period.
- .2 High temperature Control Requirements
  - .1 The following requirements are in addition to CSA A23.1, Clause 7.1.1 – Hot Weather Concreting:
    - .1 Limit peak temperature during the curing period to 40°C maximum. Placing temperature that will satisfy this requirement depends on ambient temperature, humidity at the time of placing, thickness of the concrete, and curing methods employed.
    - .2 Consider use of retarders, low heat cement, slag replacement, ice in mixing water, pre-cooling of aggregates, cooling of concrete through continuous wet curing, and similar methods in order to prevent concrete temperatures from exceeding 40°C at any time.
    - .3 Monitor concrete temperatures for walls and slabs 500 mm or more in thickness. After concrete temperature has peaked, control rate of cooling to ambient air temperature at a rate of 1/2°C per hour to prevent cracking.
    - .4 Notwithstanding requirements of subparagraphs .1 and .2 above, do not place concrete with temperature higher than 25°C. Concrete with temperature in excess of 25°C on arrival at the site will be rejected. Remove rejected concrete from the site.
- .3 Protection
  - .1 Protect freshly placed concrete from damage due to construction operations and from cold, heat, rain, snow, running water, drying winds, and any other circumstances which would likely cause deterioration of concrete quality.
  - .2 Use waterproof insulated covers or other suitable materials to enclose freshly placed concrete under these conditions.
- .4 Frost Protection for Slabs on Grade

- .1 Provide continuous protection for slabs on grade to prevent subgrade below from freezing during cold weather. Provide heated enclosures and insulation as required.
- .2 Subgrade below may be protected against frost by filling with water to a minimum depth of 2000 mm. Place log booms, 200 mm diameter, at maximum spacing of 5000 mm in each direction to abate ice pressures on tank walls. Break ice on formation.
- .5 Influence of Ambient Concrete Temperature on Concrete Crack Control
  - .1 To minimize the formation of thermal cracks during placement and curing, maintain previously cured concrete and concrete that will be placed against it at the same temperature.
  - .2 Failure to minimize temperature differential between adjacent pours will result in temperature induced cracking. Repair such cracks as specified in this Section.
- .6 Ground Vibration Limitations
  - .1 Do not place concrete if the vibration level exceeds a level that will impact setup.
- .7 Backfilling and Service Loads Restrictions
  - .1 Verify that backfill is not higher than the finished grades indicated.
  - .2 Verify that equipment for backfilling and compaction will not impose loads greater than those indicated.
  - .3 Verify that concrete in walls, and slabs, struts, and cross walls, which frame into the walls providing lateral stability, has been placed and has attained specified compressive strength before backfilling against walls or subjecting walls to service loads.
  - .4 Verify that concrete in slabs, including slabs on grade, and support components have reached specified compressive strengths before backfilling or subjecting slabs to service loads.
  - .5 Verify that the leakage test is successfully completed before backfilling.

## 2 PRODUCTS

### 2.1 Materials

- .1 Portland Cements/ Blended Hydraulic Cements
  - .1 Type GU or GUb: CSA A3001.
  - .2 Type MS or MSb: CSA A3001 for liquid holding structures.
- .2 Aggregates
  - .1 Normal density Concrete
    - .1 Coarse aggregate: CSA A23.1; rough and angular gravel or crushed stone.
    - .2 Fine aggregate: CSA A23.1; natural sand.
- .3 Admixtures
  - .1 Compatible with each other and with other concrete materials.
  - .2 Use products that are certified for potable water in construction of potable water structures.
  - .3 Calcium chloride, thio-cyanates, or admixtures containing more than 0.05% chloride ions are not permitted.
  - .4 Air entraining admixture: ASTM C260; non-detergent type.

- .5 Water-reducing admixtures: ASTM C494; Type A.
- .6 Set-retarding admixture: ASTM C494; Type B.
- .7 Superplasticizing admixture: ASTM C494; Type F 1or G 2.
- .8 Corrosion inhibitor: ASTM C494; Type C; DCI by:
  - .1 W.R. Grace Co. of Canada Ltd.
  - .2 Rheocrete CNI by Master Builders Technologies, Ltd.
- .4 Water: CSA A23.1; clear and free from oil, acid, alkali, organic matter, or other deleterious substances with a maximum soluble chloride ion content of 0.10% by weight.
- .5 Bonding agent: Suitable for conditions of service and performance requirements of this Section.
- .6 Polyurethane injection resin for sealing cracks, single-component Diphenylmethane Diisocyanate (MDI) based, water-activated, hydrophobic type resin:
  - .1 Flexible Resin by Multiurethanes Limited.
  - .2 Hydro Active Flex LV by DeNeef Construction Chemicals (U.S.) Inc.

## 2.2 Concrete Mixes

- .1 General
  - .1 Establish proportions of cementing materials, aggregates, water, and admixtures required to produce consistent workable concrete that is watertight, durable concrete with strength and other properties specified. Comply with clause 4.3.6- CSA A23.1 Volume Stability Considerations.
  - .2 Use same type and brand of cement throughout.
  - .3 Comply with and allow for the supplier's Standard Deviation as specified in CSA A23.1, Clause 4.4.6 Compressive Strength Requirements. If the concrete supplier has no established Standard Deviations for concrete of the specified strengths, use a value of 4 MPa minimum.
- .2 Types of Normal density Concrete
  - .1 Type A: Concrete for structures, equipment bases, pipe supports, containing reinforcing bars, unless specified otherwise.
  - .2 Type B: Post foundations and benching with air entrainment.
  - .3 Type C: Mud mat and fill concrete unless specified otherwise.
- .3 Mixes for Normal-density Concrete
  - .1 Coarse Aggregates
    - .1 Nominal size 40 mm to 5 mm, unless noted otherwise.
    - .2 Nominal size 20 mm to 5 mm, for walls less than 300 mm thick, slab less than 300 mm thick, beams, slabs with monolithic beams, columns, and Type B concrete.
  - .2 Water/Cementing Materials Ratio (W/C)
    - .1 Unless specified otherwise: 0.42 maximum for Type A concrete.
    - .2 High slump concrete: 0.40 maximum.
    - .3 Type B and Type C concrete: As required for strength and workability.

- .3 Slump
    - .1 Provide slump consistent with placement, consolidation methods equipment and site conditions. Ensure concrete do not segregate during placement. Comply with CSA A23.1.
    - .2 Concrete with superplasticizing admixture shall have slump of 180 mm  $\pm$  20 mm at time of discharging.
  - .4 Class of Exposure
    - .1 Class C-1 for all concrete components.
  - .5 Air Content
    - .1 Comply with CSA A23.1-14, Table 4 - Requirements for Air Content Categories Specified in Table 1 and 2.
    - .2 Provide air content category 2, unless noted otherwise.
    - .3 Provide air content category 1 for loading bays, parking areas, and liquid holding structures.
    - .4 Provide 3% maximum air content for concrete forming floors where floor hardener is used.
  - .6 Admixtures
    - .1 Use water-reducing admixture as necessary.
    - .2 Use superplasticizing admixture with a retarder when requirements of CSA A23.1, Clause 7.7.3.4.1 Hot Weather Curing are applicable.
    - .3 Use superplasticizing admixture to concrete for construction of walls and columns unless otherwise specified.
  - .4 Mix for Pumped Concrete
    - .1 Comply with ACI 304.2R and this Specification.
    - .2 Fine aggregate with uniform grading curve and fineness modulus of  $2.65 \pm 0.20$ .
    - .3 Use coarse aggregate with uniform grading curve.
    - .4 Superplasticizing admixture may be used for pumped concrete.
    - .5 Do not use admixtures which promote bleeding.
  - .5 Mix for Filling Openings and Box Outs
    - .1 Use custom blended material with the following proportions.
      - .1 In Pakt Standard Grout: 500 kg/m<sup>3</sup>.
      - .2 Fine aggregate: 700 kg/m<sup>3</sup>.
      - .3 Coarse aggregate: 700 kg/m<sup>3</sup>.
      - .4 Water: 250 kg/m<sup>3</sup>.
    - .2 Alternatively, use preblended non shrink non ferrous hydraulic cement grout complying with manufacturer's printed instructions.
- 2.3 Source Quality Control**
- .1 Testing by an independent laboratory in accordance with CSA A23.1 and CSA A23.2, where test results less than one year are not available, to determine:
    - .1 Chemical composition and physical properties of aggregates.

- .2 Presence and quantity of deleterious substances in aggregates.

### **3 EXECUTION**

#### **3.1 Preparation**

- .1 General
  - .1 Determine requirements of other trades, inform concerned trades, and assume responsibility for location, installation, and quality of items which affect the work of this Section.
  - .2 Preparation of Surfaces
    - .1 Remove water, snow, ice, loose soil, laitance, curing compound, wood, and other debris from surfaces on or against which new concrete will be placed.
    - .2 Roughen and clean surfaces of previously placed concrete against which subsequent concrete will be placed.

#### **3.2 Placing Concrete**

- .1 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 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 Place concrete between construction joints in one continuous operation.
- .2 Depositing
  - .1 Limit free drop of concrete to 1500 mm maximum in accordance with requirements of CSA A23.1, Clause 7.4.3 - Depositing.
- .3 Time Limitations on Concrete Placement
  - .1 Do not use concrete after a period of two hours has passed since first mixing of ingredients.
  - .2 Do not use high slump concrete after slump falls below 100 mm for non-flowing concrete and 125 mm for flowing concrete. Where permitted, retemper in accordance with manufacturer's printed instructions. Monitor, and correct if required, air content of concrete that has been retempered.
- .4 Adverse Weather Conditions
  - .1 Make suitable arrangements to prevent damage to fresh concrete, under adverse weather conditions.
  - .2 Do not allow rain, sleet, or snow to increase mixing water or damage surface finish.
- .5 Wall and Column Grout

- .1 Deposit 75 mm of wall and column grout evenly along horizontal construction joints in bottom of form through an elephant trunk immediately before placing wall or column concrete.
- .6 Time Interval Between Concrete Placements
  - .1 Control shrinkage cracking by allowing a period of seven days or more if necessary, before placing subsequent wall concrete against walls in place, or subsequent slab concrete against slabs in place.
  - .2 Walls and columns may be placed on slabs and vice versa as soon as initial placing has sufficient strength but not sooner than 12 hours.
- .7 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 the conduits, waterstops, to make sure thorough contact.
  - .3 Bend edge of horizontal waterstops, slightly upward allowing concrete to flow under and completely fill space below the waterstop. Verify no air is trapped below waterstop and concrete is in contact with waterstop over its entire surface area.

### **3.3 Repair of Temperature and Shrinkage Induced Cracks**

- .1 Repair cracks in the completed structures employing a suitable polyurethane injection technique to make such cracks completely watertight after repair.
- .2 Remove surface injection materials following completion of work and finish affected areas to match surrounding concrete.

### **3.4 Field Quality Control**

- .1 General
  - .1 Tests will be made throughout progress of the Work and will be paid for by the Owner to determine concrete quality. Tests will be in accordance with CSA A23.1 and CSA A23.2. Provide labour, concrete, and other facilities for making the test specimens.
  - .2 Provide and maintain facilities for storing and initial curing of test cylinders and provide suitable crates for shipping test cylinders in accordance with CSA A23.2-14, Test Method A23.2 3C Making and Curing Concrete Compression and Flexural Test Specimens.
  - .3 The testing laboratory shall provide the test results to the Owner, Engineer, Contractor and material supplier within 5 days of availability. For test that fail to meet the Specification inform Engineer, Contractor and material supplier within 48 hours.

- 
- .2 Standard Strength Tests
    - .1 Provide concrete for one standard strength test consisting of 4 cylinders for each 50 m<sup>3</sup> of concrete of each type placed in any day. If the amount placed, for each type of concrete is less than 50 m<sup>3</sup> in a day, provide concrete for one standard strength test. One cylinder will be tested at 3 days, one at 7 days and two at 28 days.
    - .2 Additional test cylinders will be taken during cold weather concreting as directed by Engineer. Cured test cylinders on job site under same conditions as concreting it represents.
  - .3 Concrete Temperature Monitoring
    - .1 Provide and keep in working order sufficient Taylor Instrument pocket biotherm thermometers model 6097 1 to monitor concrete temperatures in each pour.
    - .2 Install 12 mm diameter by 150 mm deep copper tubes crimped at bottom end into concrete at each monitoring location. Fill tube with water.
    - .3 Monitor concrete temperature at corners and in the centre of each concrete placement.
  - .4 Air Content Tests
    - .1 Testing agency will carry out air content tests in accordance with CSA A23.1 and CSA A23.2.
  - .5 Slump Tests
    - .1 Testing agency will carry out slump tests in accordance with CSA A23.1 and CSA A23.2.
  - .6 Failure to Meet Strength, Air Content, or Slump Requirements
    - .1 When measured slump or air content falls outside of required limits, carry out a check test immediately on another portion of the same sample. In the event of a second failure, the concrete will be considered to have failed to meet the requirements. Remove the whole batch, from which the samples were taken, off the site.
    - .2 When the strength requirement provisions are not met, carry out one or more of the alternatives of CSA A23.1, Clause 4.4.6.6.1.2 Failure of Standard Cured Cylinder Test Results to Meet Requirements.
    - .3 When, after carrying out these requirements, there is still doubt about of the adequacy of the concrete, strengthen or replace, as directed, portions of the Work which failed to develop the required strength.
  - .7 Uniformity of Mixed Concrete
    - .1 If the results of slump, air content or density for any mix design do not comply with CSA A23.1-14, Table 13 Determination of Within Batch Uniformity, alter mixing operations and equipment until tests indicate that the requirements are satisfied.
  - .8 Concrete Delivery Records
    - .1 Submit with each batch of concrete before unloading, a typed delivery ticket prepared at the ready-mix plant containing following information:
      - .1 Name of ready mix batch plant.
      - .2 Serial number of ticket.

- .3 Date and truck number.
- .4 Name of Contractor.
- .5 Name of Job.
- .6 Specified 28-day strength of concrete with identifying mix number.
- .7 Time loaded or of first mixing of cement and aggregates.
- .8 Temperature of Fresh Concrete.
- .2 Keep records of the time when each load arrives at the site and when discharge is completed.

**END OF SECTION**

## 03480 Precast Concrete Specialties

### 1.0 General

#### 1.1 Scope of work

- .1 Supply and install watertight precast concrete valve chamber complete with base and lid per the dimensions and depth as shown on the drawings. Precast shall be manufactured in accordance with CSA A23.4-14 guidelines and as described herein.
- .2 Include all knockout panels, box outs, grouting, waterstops, anchors, sleeves, lifting lugs, joint fillers, sealant and waterproofing etc.

#### 1.2 Related Sections

- .1 Section 02200 – Earthwork
- .2 Section 02210 – Grading
- .3 Section 02250 - Compaction Control and Testing
- .4 Section 02600 – Underground Piping
- .5 Section 07110 - Bituminous membrane waterproofing

#### 1.3 Submittals

- .1 Submit shop drawings of precast concrete valve chamber including precast concrete riser sections, precast concrete top and base slab including dimensions, design loads, reinforcement details and connection details. Indicate locations of knout panels, box-outs, etc. Shop drawings shall be signed and sealed by a licensed Professional Engineer in the Province of Ontario.
- .2 Submit certified design calculations for Engineer to review.
- .3 Submit information regarding product data and details of installation.

#### 1.4 Basis of Payment

- .1 The lump sum price bid in the Form of Tender shall include supply of all materials, labour and equipment to install precast concrete products described in this specification.

## 2.0 Products

### 2.1 Materials

- .1 Precast watertight concrete chambers:
  - .1 Portland cement: to CAN/CSA-A3001. Use Type GU cement. Blended hydraulic cements: to CAN/CSA A3001-03.
  - .2 Other cementing materials: to CAN/CSA-A3000 & A23.1.
  - .3 Grout: SIKA 212SR or equivalent, unless noted otherwise.
  - .4 Hydrophilic Rubber Waterstop: Hydrotite CJ or approved equivalent.
  - .5 Provide rubber adhesive, epoxy gel and single component hydrophilic sealant in accordance with manufacturer's written recommendations.

- .6 Premoulded joint filler shall be PVC closed cell foam rigid grade or approved equivalent.
- .7 Joint Sealer: Sikaflex 1A with primer (Sika Canada) or approved equivalent.
- .8 Bonding Agent: Sikatop Armatec 110 EpoCem or approved equivalent.
- .9 Admixtures: Conform to CAN3-A266.1-M, CAN3-A266.2-M and CAN3-A266.3-M.
- .10 Aggregates: Conform to CAN/CSA-A23.1-M and M.T.O. Forms 1000 and 1002. Petrographic Number of coarse aggregate not to exceed 125. Submit aggregate analysis for Engineer's review.
- .11 Reinforcement : CSA G30.12M, Grade 400W.
- .12 Minimum concrete compressive strength: 35 MPa at 28 days.

## **2.2 Acceptable Supplier**

- .1 Pre-Cast Chambers shall be supplied by:  
OMNI Precast, Coldstream Concrete Ltd., or approved equal.

## **3.0 Execution**

### **3.1 Installation of precast concrete valve chamber**

- .1 Install excavation protection system as indicated on Civil Drawings.
- .2 Excavate to base elevation. Excavation must conform to the requirements of the Occupational Health and Safety Act and Regulations for Construction Projects of Ontario.
- .3 Install precast concrete valve chamber complete.
  - .1 Provide all necessary openings for forcemain, chemical lines, drainage pipe, wires and conduits.
  - .2 Watertightness and Watertightness Testing
    - .1 It shall be the responsibility of the Contractor to provide concrete work that shall, with the exception of the natural porosity of the concrete, be watertight in every respect. Any defects or cracking in walls or slabs which shall permit the infiltration of groundwater or the leakage of the contents of chambers and/or channels, shall, if in the opinion of the Consultant such defects or cracks are the result of negligence or the use of faulty materials or faulty workmanship on the part of the Contractor, be repaired and rendered watertight by the Contractor at no additional expense to the Owner. Cracking which occurs between construction joints, the spacing of which exceeds that specified under construction joints, or shown on the Contract Drawings, shall be considered the result of negligence on the part of the Contractor and shall be likewise repaired by the Contractor at his sole expense.
    - .2 Concrete cracks shall be injected or repaired by cutting out the crack to a depth of one inch and a width of one-half inch and sealing the resulting recess with an approved two-component polyurethane sealant.
  - .3 Protection Against Flotation:
    - .1 Provisions shall be made to prevent damage to structure due to hydrostatic pressure during the entire period of construction.

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- .2 Refer to Geotechnical Report for general soil and groundwater information. Groundwater should be assumed to be at grade elevation for floating calculations.
  - .3 Provide all labour, plant and materials necessary to keep excavations stable and free of water. The cost for all labour, equipment and materials required for dewatering to perform the work as specified shall be included in the tendered lump sum price for the Valve Chamber.
  - .4 No extra payment will be made for measures ordered by the Engineer to correct problems caused by improper installation and/or inadequate dewatering.

**END OF SECTION**

**DIVISION 5**  
**METALS**

**Division 5 Metal - Index**

*05000 General*

*05500 Metal Fabrications (Basic)*

*05520 Metal Fabrications (Structural)*

**End of Section**

## **1.1.1 05000 General**

### **1.0 General**

#### **1.1 Order of Priority**

- .1 The instructions given in this Section are to be given precedence with regard to Contract interpretation over the following sections within this Division.
- .2 Notwithstanding clause 1.1.1 above, instructions given Division 1 – General Requirements are to be given precedence with regard to Contract interpretation over those in this Division.

#### **1.2 Intent of Specifications**

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.2.2 of this Section at no additional cost to the Owner except as allowed in the sole discretion of the Engineer.

#### **1.3 Engineer and Contract Administrator**

- .1 In this Division, Engineer and Contract Administrator are deemed to have the same meaning.
- .2 The Engineer is as defined in the General Conditions section of this Contract.

#### **1.4 Submission of Alternate Proposals for Products or Materials**

- .1 If the Contractor requests use of an alternate product or material then he/she is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract in accordance with Section 01200.
- .2 If an alternative product or material is accepted for use then the Contractor is responsible at his/her cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .3 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.

**END OF SECTION**

## 05500 Metal Fabrication (Basic)

### 1 GENERAL

#### 1.1 Summary

- .1 Comply with Division 1: General Requirements.
- .2 Metal Fabrications (Structural): Refer to Section 05520: Metal Fabrications (Structural).

#### 1.2 References

- .1 CAN/CGSB-1.108-M Bituminous Solvent Type Paint.
- .2 CGSB 1 GP 181M Coating, Zinc Rich, Organic, Ready Mixed.
- .3 CSA S16 Design of Steel Structures.
- .4 CSA G40.21 General Requirements for Rolled or Welded Structural Quality Steel.
- .5 CSA G164 Hot Dip Galvanizing of Irregularly Shaped Articles.
- .6 CSA S157 Strength Design in Aluminum.
- .7 CSA W47.1 Certification of Companies for Fusion Welding of Steel Structures.
- .8 CSA W47.2 Certification of Companies for Fusion Welding of Aluminum.
- .9 CSA W55.3 Certification of Companies for Resistance Welding of Steel and Aluminum.
- .10 CSA W59 Welded Steel Construction (Metal Arc Welding).
- .11 CSA W59.2 Welded Aluminum Construction.
- .12 ASTM A36M Specification for Structural Steel.
- .13 ASTM A48 Specification for Gray Iron Castings.
- .14 ASTM A53 Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
- .15 ASTM A153 Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .16 ASTM A167 Specification for Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet, and Strip.
- .17 ASTM A193M Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature Service.
- .18 ASTM A194M Specification for Carbon and Alloy Steel Nuts and Bolts for High Pressure and High Temperature Service.
- .19 ASTM A307 Specification for Carbon Steel Bolts and Studs, 60000 psi.
- .20 ASTM A312M Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
- .21 ASTM A325 Specification for High-Strength Bolts for Structural Steel Joints.
- .22 ASTM A511 Specification for Seamless Stainless Steel Mechanical Tubing.
- .23 ASTM A525M Specification for General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot Dip Process.
- .24 ASTM A563M Specification for Carbon and Alloy Steel Nuts.

- .25 ASTM A570M Specification for Hot Rolled Carbon Steel Sheet and Strip, Structural Quality.
- .26 ASTM A611 Specification for Steel, Cold Rolled Sheet, Carbon, Structural.
- .27 ASTM A666 Specification for Austenitic Stainless Steel, Sheet, Strip, Plate and Flat Bar for Structural Applications.
- .28 ASTM A743M Specification for Castings, Iron Chromium, Iron Chromium Nickel, and Nickel Base Corrosion Resistant for General Application.
- .29 ASTM A780 Practice for Repair of Hot Dip Galvanized Coatings.
- .30 ASTM B26M Specification for Aluminum Alloy Sand Castings.
- .31 ASTM B209M Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- .32 ASTM B221M Specification for Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
- .33 ASTM B241M Specification for Aluminum and Aluminum Alloy Seamless Pipe and Seamless Extruded Tube.
- .34 ASTM B316 Specification for Aluminum Alloy Rivet and Cold Heading Wire and Rods.
- .35 ASTM B468 Specification for Welded Chromium – Nickel – Iron Molybdenum Copper Columbium Stabilized Alloy Tubes.
- .36 ASTM B632M Specification for Aluminum Alloy Rolled Tread Plate.
- .37 ASTM B766M Specification for Electro-deposited Coatings of Cadmium.
- .38 ASTM F436M Specification for Hardened Steel Washers.
- .39 ASTM F467M Specification for Non Ferrous Nuts for General Use.
- .40 ASTM F468M Specification for Non Ferrous Bolts, Hex Cap Screws, and Studs for General Use.
- .41 ASTM F738-M Specification for Stainless Steel Metric Bolts, Screws and Studs.
- .42 ASTM F1136 Specification for Chromium/Zinc Corrosion Protective Coating for Fasteners.
- .43 ANSI B36.10 Pipe, Steel.
- .44 ANSI/NAAMM MBG 531-88/NAAMM Metal Bar Grating Material.
- .45 CISC/CPMA 2 75a A Quick Drying Primer for use on Structural Steel.

### 1.3 System Description

- .1 Design Requirements
  - .1 Design miscellaneous metal items in accordance with applicable standards.
  - .2 Design work of this Section, which will support other items or will be required to support structural loads of any nature, by a professional structural engineer licensed in the Province of Ontario. Affix professional seal and signature to shop drawings for such items.
  - .3 Design connections and splices using high strength bolts or welds. Use bearing type bolts for bolted connections.
  - .4 Design connections for moments, shears and axial loads indicated or specified.

- .5 Where no moments, shears or axial loads are indicated design in accordance with CSA S16 requirements for Simple Construction. Design connection for greater than half the shear capacity of the member unless indicated otherwise.
- .6 Design connection for Hollow Structural Sections to develop full strength of member in tension or compression.
- .7 Unless design loads are indicated, design splices for the full strength of the member in bending, shear and axial load.
- .8 Unless design loads are indicated, design end connections and/or splices in bracing members for the full axial strength of the member.
- .9 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.
- .10 Design aluminum work to CSA S157 and CSA W59.2.

#### **1.4 Submittals**

- .1 Shop Drawings: Submit shop drawings before fabrication commences of each metal fabrication item, showing in large scale fabrication details, thickness, anchors, location and finishes.
- .2 Submit welding procedure specification for each type of material.
- .3 Submit sample of aluminum railing including a welded joint to the Engineer for acceptance. Commence fabrication only after acceptance has been obtained.
- .4 Samples: Submit two (2) samples of each finish.

#### **1.5 Quality Assurance**

- .1 Ensure workmanship of the highest quality throughout by employing only metal workers that have demonstrated the highest skills in this type of work and qualified welders certified to weld the materials used in fabrication of the miscellaneous metals.
- .2 Welding Procedure for Steel and Stainless Steel
  - .1 Submit certificate that companies which will be welding stainless steel are CSA accepted.
  - .2 Comply with CSA W47.1 and W59.
- .3 Welding Procedure for Aluminum
  - .1 Submit certification that companies which will be welding aluminum are CSA accepted.
  - .2 Comply with CSA W47.2 and CSA W59.2.

#### **1.6 Delivery, Storage and Handling**

- .1 Provide protective coating on stainless steel and aluminum items.

## **2 PRODUCTS**

### **2.1 Materials**

- .1 Where anchors, lifting hooks, screws, bolts, nuts, washers, hangers and other fasteners are not specifically shown or specified, provide such items with at least the strength and corrosion resistance properties of the metal fabrication for which they are required.

- .2 Structural Steel and Loose Lintels: CSA G40.21, Grade 300W. Use Grade 350W for W shapes.
- .3 Structural Steel for Hollow Sections: CSA G40.21 Grade 350W, Class H.
- .4 Steel General Purpose: ASTM A36 Table 1 Material Specifications.
- .5 Steel anchors, studs, taps and bolts: ASTM A307, Grade B carbon steel.
- .6 Cast Iron: ASTM A48 Class 30, grey galvanized steel.
- .7 Galvanized steel sheet: ASTM A525, Z275 zinc coating class.
- .8 Hot rolled steel sheet: ASTM A570.
- .9 Cold rolled steel sheet: ASTM A611.
- .10 Steel Pipe: ASTM A53 Type S Grade A or ANSI B36.10.
- .11 Neoprene: Premium grade Durometer A 40.
- .12 Fasteners: ASTM F1136, galvanized.
- .13 Stainless Steel: Alloy 316.

Item	ASTM	UNA Designations
Structural	A666	S30400
Architectural	A666	S30400 or S31600
Plates, Sheets and Strips	A167	S30400 or S30403
		<u>Grade</u>
Fasteners	F738, F1136, A193, A194	B8A
Castings	A743	CF-8M
Tubing	A511	MT-304 or
	A511	MT304L

- .14 Stainless steel pipe: ASTM A312 Seamless Pipe.
- .15 Aluminum

Item	ASTM	UNA Designations
Extruded Shapes - Structural	B211M	A96351-T6
Extruded Shapes - Architectural	B221M	A96063-T6
Smooth Plates and Sheets	B209M	A93003-H16
Checkered or Tread Plates	B632M	A96061-T6
Gratings	B221M	A96061-T6
Rivets	B316	A96061-T6
Castings	B26	A03560-T6 or A05350-F
Tubing & Pipe	B241M	A96061-T6
Fasteners - Bolts	F468M	A96061-T6
- Nuts	F467M	A96061-T6

- .16 Primer: CISC/CPMA 2 75a unless otherwise required for finish coating under Section 09900.
- .17 Isolation coating: CAN/CGSB 1.108 M, quick drying asphalt utility enamel.

.18 Zinc rich primer: CGSB 1 GP 181M, Sealtight Galvafruid Zinc Rich Coating by W.R. Meadows Ltd.

.19 High Strength Bolts – ASTM A325.

## 2.2 Finishes

.1 Rough Edges and Mill Scale

.1 Following completion of fabrication of any item, grind rough edges straight and finish smooth. Remove mill scale and rust.

.2 Electrolytic Corrosion

.1 Backpaint metal surfaces in contact with dissimilar metal or concrete or masonry, with bituminous paint, 1.0 mm DFT minimum.

.2 Paint galvanized metal surfaces to be in contact with or encased in concrete with rust inhibitive epoxy coating ICI Devoe Coating: Devran 201. Prepare surfaces to SSPC SP1, apply paint to 125 microns DFT.

.3 Aluminum

.1 Restore aluminum to original mill finish after fabrication. Buff and brighten exposed aluminum surfaces, which have been damaged during construction.

.2 Where aluminum is intended to be in contact with either dissimilar metals, concrete, or masonry, paint the surfaces to be in such contact with two coats of aluminum coloured bituminous paint.

.3 Use anodizing quality aluminum where anodizing is required.

.4 Carbon Steel

.1 Where carbon steel is intended to be exposed to atmospheric conditions or sewage, hot dip galvanize the metal fabrications.

.2 Where carbon steel is intended to be in contact with concrete, brick or mortar, hot dip galvanize the surfaces to be in such contact.

.5 Galvanizing

.1 Hot-dip galvanize items after fabrication. Galvanize steel scheduled for exposure to exterior conditions or corrosive materials.

.2 Clean surfaces to be galvanized of slag and impurities immediately before being galvanized or cadmium plated.

.3 Where specified or detailed, galvanize plates and other structural shapes in accordance with CSA G164. Where fabrications are too large to be hot dipped, employ zinc metallizing.

.6 Repair of Damaged Galvanized Surfaces

.1 Repair hot dip galvanized coatings damaged by welding, cutting, rough handling during shipping or erection or otherwise, in accordance with ASTM A780 using organic zinc rich primer. Dry film thickness on repairs to exceed original coating thickness by 25%.

.7 Cadmium Plating

.1 Clean surfaces, to be cadmium plated, of slag and impurities immediately before being cadmium plated.

.2 Where specified or detailed, cadmium plate metal fabrications and fasteners in accordance with ASTM B766. Use coating thickness on threaded articles

equivalent to Type TS. For surfaces other than threaded areas provide coating thickness equivalent to Type NS.

- .8 Anodized finish: Anodizing Architectural Class I Anodic Coating 0.018 mm (0.7 mil) thickness, one hour coating 215 RI (AA C22A41 clear) proceeded by a caustic etch.
- .9 Stainless Steel
  - .1 Remove rust and postweld discoloration from stainless steel by grinding, using only stainless steel tools.
  - .2 Passivate stainless steel, which was cleaned by grinding, with a solution of 12-15% nitric acid and 3% hydrofluoric acid.
  - .3 Finishes: No. 4 finish XL Blend S

### **2.3 Anchors and Fasteners**

- .1 Anchors, Studs, Taps and Machine Bolts
  - .1 For structural connections at platforms, support frames and similar items, use stainless steel type 316 bolts, nuts, and washers.
  - .2 Unless otherwise specified or detailed use hot dip galvanized or stainless steel anchors and fasteners. Wet well metal cover plate framing system to use stainless steel anchors and fasteners.
  - .3 Use corrosion resistant fasteners of stainless steel or aluminum for corrosion resistant items to be fastened.
- .2 Bolts or Studs Used as Anchors: 75 x 75 x 10 mm steel plate welded to the bolt head or stud.
- .3 Grout: Set by Master Builders Technologies Ltd. M Bed Standard or Sika Grout 212 by Sika Canada Inc.
- .4 Drilled anchors: Hilti stainless steel HVA, HSL, or Kwik bolts as indicated or accepted.
- .5 Anchor grout for submerged and exterior conditions: Epoxy acrylate resin HVA by Hilti Ltd.

### **2.4 Fabrication - General**

- .1 Where possible, verify dimensions on site before preparing shop drawings or proceeding with shop work. Fit and shop assemble insofar as possible various sections of the work and deliver to the project site in the largest practical sections.
- .2 The general dimensions and details of the metal fabrications are shown on the Drawings where practical. Such details and dimensions are suggested concepts for design.
- .3 Assume responsibility for the correctness of the actual detailed dimensions used in fabrication and carefully check the same, by field measurement.
- .4 Variations from suggested details are subject to acceptance in writing by the Engineer. Such acceptance does not in any way waive the above mentioned responsibility.
- .5 Wherever overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Rusting or deterioration of finish in such areas will require remedial seal welding and refinishing.
- .6 Fabricate the work true to dimensions and square. Accurately fit members with hairline joints, and join using adequate fastening.
- .7 Construct finished work free from distortion and defects detrimental to appearance and performance.

- .8 Stainless steel grain direction: One direction throughout.
- .9 File or grind exposed welds smooth and flush. Finish joint to match adjacent surface finish. Do not leave grinding marks. Construct internal and external corners with sharp lines. Provide continuous welds unless otherwise accepted by the Engineer in writing. Brighten and buff aluminum and stainless steel welds to match appearance of adjacent surface.
  - .1 Remove weld spatter and slag. After finish grinding and smoothing welds, passivate welds with pickling paste.
  - .2 Preheat members thicker than 19 mm before welding.
- .10 Weld aluminum in accordance with CSA W47.2.
  - .1 Use weld rod No. 5356 for clear anodized aluminum of 6063 T5 alloy.
- .11 Fabricate metal work complete with components required for anchoring to concrete; bolting or welding to structural steel frames; standing free; or resting in frames or sockets, in a safe and secure manner.
- .12 Countersink exposed fastenings, where such are accepted in writing, and make as inconspicuous as possible with bolts cut off flush with nuts. Construct fastenings of the same material and finish as the base material on which they occur.

### **3 EXECUTION**

#### **3.1 Installation - General**

- .1 Install work of this Section using skilled craftsmen and in accordance with manufacturer's recommendations where applicable.
- .2 Install metal fabrications in the correct locations and positions, plumb, level, structurally sound, securely fastened, free from defects detrimental to finished appearance and to acceptance of the Engineer.
- .3 Perform drilling of steel, concrete or masonry to fasten the work of this Section.
- .4 For aluminum and stainless steel items, and exterior locations, use stainless steel anchors.
- .5 After installation, spot prime bolt heads and nuts, field rivets, field welds and any abrasions or damage to the shop coat of primer.
- .6 Touch up galvanized steel where galvanizing is damaged during installation with zinc rich primer.
- .7 Apply isolation coating to surfaces between dissimilar metals, and between metal and concrete, mortar, grout or masonry.
- .8 Where items are specified to be installed by other Sections, fabricate items to the appropriate trade with necessary instructions and templates required for proper installation. Include required fastenings, such as screws, bolts, expansion shields and similar items.
- .9 Tolerances: CSA S16.
- .10 Deliver items to be cast into concrete with instructions for setting.

### **3.2 Installation – Anchors and Fasteners**

- .1 Arrange bolts with sufficient length to embed 100 mm in the structural floor slab and to project the threaded position a minimum of 50 mm above the proposed elevation of the base plate or mounting plate.
- .2 Set anchor bolts accurately in holes in concrete using plywood templates prepared from manufacturer's shop drawings. Set items in grout. Use anchor grout for submerged and exterior conditions.
- .3 Do not offset bolts by deformation.
- .4 Secure lateral support units for masonry walls at 600 mm o.c.
- .5 For submerged conditions where bolts are used, use lock nuts or nuts with lock washer.

END OF SECTION

## 05520 Metal Fabrications (Structural)

### 1 GENERAL

#### 1.1 Summary

- .1 Comply with Division 1 General Requirements.

#### 1.2 References

- .1 Provide metal fabrications in accordance with the following standards (latest revision) except where specified otherwise.

ASTM A276	Specification for Stainless Steel Bars and Shapes
ASTM A320	Specification for Alloys, Steel Bolting Materials for Low-Temp service
CSA-G40.21	Structural Quality Steel
CSA-W47.1	Certification of Companies for Fusion Welding of Stainless steel
CSA W59.1	Welded Stainless Steel Construction

- .2 ANSI/NAAMM MBG 531-88/NAAMM Metal Bar Grating Material.

#### 1.3 Shop drawings

- .1 Submit shop drawings stamped by a Professional Engineer registered in the Province of Ontario, to the Engineer for review prior to fabrication
- .2 Indicate materials, thicknesses, weld symbols, reinforcement, details and accessories.
- .3 Manufacturer shall supply installation drawings and instructions.

#### 1.4 Fabrication – Aluminum Gratings (Not Applicable)

- .1 Fabricate aluminum gratings of the swage lock type indicated, designed and reinforced for a uniformly distributed load of 4.8 kN/m<sup>2</sup> with deflection not to exceed 6 mm maximum, unless specifically noted on drawings otherwise.
- .2 Aluminum swage locked grating:
  - .1 IKG Borden Type BS by IKG Industries, Ltd.
  - .2 Fisholow Aluminum Type 30-102M by Fisher & Ludlow.
  - .3 Borden Aluminum Type S/B by Borden Metal Products (Canada) Limited.
- .3 Fabricate swage locked grating with the following features:
  - .1 Full depth load bearing band bars at cutouts, welded full depth to each bearing bar with weld size to suit design loading criteria.
  - .2 Full depth trim band bars except at trench grating provide less depth to allow for drainage. Weld trim band bars at every third bearing bar with minimum 3 mm fillet weld size by 19 mm long.
  - .3 Serrated surface.
  - .4 Mill finish.
  - .5 Removable type aluminum anchorage devices.

- .6 Fabrication and tolerances in accordance with ANSI/NAAMM MBG 531-88.
- .4 Fabricate aluminum angle frames or seat angles to support the gratings having neatly fitted, welded, mitred corners. Shop weld strap anchors to angle frames. Size angle frames to fit grating with clearances between frames and gratings not exceeding 6 mm on any side. Apply isolation coating to exterior of frame in contact with concrete.
- .5 FALL PREVENTION NET: Provide and install a fall prevention grating system for each floor hatch. The grating system shall meet or exceed all current Occupational Safety and Health Administration standards and be designed to prevent falling through the opening. The grating shall be designed to be installed in the vault horizontal access hatch. The grating system shall be manufactured of fiberglass and be resistant to ultraviolet light and corrosive atmospheres. The grating system shall include lift assistance and an automatic hold open arm for ease of operation and user safety. The open arm shall automatically lock the grating panel in 90 degree position. A release handle shall be provided to allow the grating to be closed and locking the grating for unauthorized access. The grating system shall be equipped with stainless steel hardware and rated for a 300 psf live load. The manufacturer shall provide a full twenty five (25) year warranty on hardware and grating panel. The fall prevention system shall be manufactured by MSU, Flygt, Bilco or approved equal.
- .6 Acceptable manufacturers:
  - .1 MSU Mississauga, Type GT with Drainage frame, 2222 S Sheridan Way, Mississauga, ON L5J 2M4. (905) 823-4340

### 1.5 Fabrication – Aluminum Ladders

- .1 Aluminum construction equivalent to OPSD-406.010 with stainless steel bolts. Provide safety handles equal to MSU #3100 double rail access handle where ladder is to be accessible from the exterior. Material to be Aluminum Alloy Type 6061-T6
- .2 All ladders shall be 400 mm (16") wide.
- .3 Safety handle extensions: Model #3100-T Safety Post as supplied by MSU Mississauga Limited.

### 1.6 Stainless Steel Access Ladders (Not Applicable)

- .1 Materials
  - .1 Structural shapes shall be Type 316L stainless steel, fasteners and anchoring system shall be Type 316 stainless steel, Slip resistant, perforated rung material shall be 316L Stainless Steel.
  - .2 Stainless steel ladders shall have extendable safety handles.
  - .3 Top of ladder shall be fitted with heavy duty retractable, double access posts, MSU Model No. 3100 (Dual). Provide additional wall brackets for added ladder strength. All fasteners to be Type 316 stainless steel.
- .2 Fabrication
  - .1 Fabricate square, true, and accurate to required size, with joints closely fitted. Remove all burrs and sharp edges.
  - .2 Wall attachment brackets shall be offset 150mm, 180mm or as required.
  - .3 Vertical rung spacing shall be 300mm centre to centre.
  - .4 Attachment brackets shall be spaced at 1200mm maximum centre to centre.

- .5 Attachment anchors shall be expansion type for new concrete or as dictated by the concrete.
- .6 The ladders shall have clear 400mm width between side rails. Provide the appropriate ladders complete with all necessary attachment brackets as shown on the Contract Drawings. Ensure all ladders are: assembled using GMAW welding method, supplied with 6 x 50mm flat bar side rails, supplied with 28 x 43mm 3 hole perforated slip-resistant rungs, supplied with brackets which are 6 x 50 bent flat bar welded to ladder side rail & offset from the wall face as required, .supplied with 12 x 95mm long 304ss wedge anchor assemblies as manufactured by Hilti.
- .3 Acceptable manufacturers:
  - .1 MSU Mississauga Ltd. 2222 S. Sheridan Way, Mississauga, Ontario L5J 2M4, 1-800-268-5336
  - .2 Or approved equal.

### 1.7 Fabrication – Aluminum Removable Plate Cover and Framing

- .1 Design diamond pattern aluminum cover plate and framing in accordance with Ontario Building Code and for additional requirements specified.
- .2 Design system to support 7.2 kPa superimposed service live load.
- .3 Design the framing sections to limit deflection to 1/360th of the span under design load.
- .4 All fasteners to be stainless steel type 316.
- .5 Paint all aluminium in contact with concrete with two coats of bituminous paint.
- .6 Provide neoprene gaskets between plate and framing members.
- .7 Fabricate hinged access panels where indicated on the Drawings. Field verify all dimensions and coordinate with process shop drawings for pump sizes for pump access hatches. Refer to 1.8 for requirements of aluminum equipment and access hatches.
- .8 Fabricate the cover consisting of aluminum structural sections and aluminum diamond pattern plate. Provide framed openings for ventilation as shown on the drawings and as required by process equipment.
- .9 Submit shop drawings certified by a Professional Engineer in the Province of Ontario.

### 1.8 Fabrication – Aluminum Equipment and Access Hatches

- .1 Design, furnish, and install access and equipment hatches where indicated on the Contract Drawings. Length denotes hinge side. The access hatch shall be pre-assembled from the manufacturer.
- .2 Performance characteristics
  - .1 Covers: Diamond-pattern tread plate reinforced to support a minimum live load of 150 psf (734 kg/m<sup>2</sup>) with a maximum deflection of 1/150th of the span.
  - .2 For access and equipment hatches located at the wet well, design live loads shall be minimum 150psf, unless higher loads are otherwise noted on Drawings.
  - .3 Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  - .4 Operation of the cover shall not be affected by temperature.

- .5 Entire door, including all hardware components, shall be highly corrosion resistant. Please consult the manufacturer when doors are to be installed in unusually harsh environments or extremely corrosive conditions.
- .3 Materials and Construction
  - .1 Covers: Shall be 10 mm (3/8") minimum aluminum diamond pattern.
  - .2 Frame: Channel frame shall be 1/4" (6.3mm) extruded aluminum with bend down anchor tabs around the perimeter. A continuous EPDM gasket shall be mechanically attached to the aluminum frame to create a barrier around the entire perimeter of the cover and significantly reduce the amount of dirt and debris that may enter the channel frame.
  - .3 Hinges: Hinges shall be specifically designed for horizontal installation, through bolted to the cover with tamperproof Type 316 stainless steel lock bolts, and through bolted to the frame with Type 316 stainless steel bolts and locknuts.
  - .4 Drain Coupling: Provide a 1/2" (38mm) drain coupling located in the right front corner of the channel frame.
  - .5 Lifting mechanisms: Manufacturer shall provide the required number, a minimum of two, and size of compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. 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 fastened to a formed 1/4" gusset support plate. Hatch shall be equipped with an automatic hold open arm.
  - .6 Latch: Type 316 stainless steel slam lock with fixed interior handle and a removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug.
  - .7 Gasket: EPDM gasket mechanically attached to the frame reduces the amount of dirt and debris that may enter the channel frame.
- .4 Hardware
  - .1 Hinges: Heavy forged aluminum hinges, each having a minimum 1/4" (6.3 mm) diameter Type 316 stainless steel pin, shall be provided and shall pivot so the cover does not protrude into the channel frame.
  - .2 Covers shall be equipped with a hold open arm, which automatically locks the cover in the open position.
  - .3 Covers shall be fitted with the required number, a minimum of two, and size of compression spring operators. Springs shall have an electrocoated acrylic finish. Spring tubes shall be constructed of a reinforced nylon 6/6-based engineered composite material.
  - .4 A Type 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover.
  - .5 Hardware: Engineered composite compression spring tubes. Steel compression springs with electrocoated acrylic finish. All other components of door are aluminum or anticorrosion, Type 316 stainless steel throughout.
- .5 Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

- .6 FALL PREVENTION NET: Provide and install a fall prevention grating system for each floor hatch. The grating system shall meet or exceed all current Occupational Safety and Health Administration standards and be designed to prevent falling through the opening. The grating shall be designed to be installed in the vault horizontal access hatch. The grating system shall be manufactured of fiberglass and be resistant to ultraviolet light and corrosive atmospheres. The grating system shall include lift assistance and an automatic hold open arm for ease of operation and user safety. The open arm shall automatically lock the grating panel in 90 degree position. A release handle shall be provided to allow the grating to be closed and locking the grating for unauthorized access. The grating system shall be equipped with stainless steel hardware and rated for a 150 psf live load. The manufacturer shall provide a full twenty five (25) year warranty on hardware and grating panel. The fall prevention system shall be manufactured by Flygt, Bilco or approved equal.
- .7 Acceptable manufacturers:
  - .1 BILCO Company, P.O. Box 1203, New Haven, CT 06505, Type J-AL Hatches
  - .2 MSU Mississauga
  - .3 ITT/Flygt Safe-Hatch
- .8 Shop drawings shall be submitted to the Engineer for review prior to fabrication.

#### **1.9 Aluminum Handrail and Posts (Not applicable)**

- .1 Design and fabricate handrail system in accordance with the requirements of the Ontario Building Code for the following loading conditions:
- .2 Minimum horizontal load of 0.75 kN/m applied inward or outward at the top railing or guard, or a concentrated horizontal load of 1.0 kN. applied at any point along the top railing or guard, whichever loading governs.
- .3 Minimum concentrated load of 0.5 kN applied to any other element within the railing or guard assembly, not acting simultaneously with the minimum horizontal load.
- .4 Minimum vertical load of 1.5 kN/m applied to the top rail or guard, not acting simultaneously with the minimum horizontal load.
- .5 38 diameter I.P.S. Schedule 40 Aluminum pipe railing and posts (welded construction).
- .6 Aluminum alloy, 6063-T6 or 6351-T6 with clear anodized finish.
- .7 Grind smooth all welded connections before anodizing work.
- .8 Maximum spacing between posts is 1.5 m or as indicated on Contract Drawings.
- .9 All fasteners and hardware shall be Type 316 stainless steel.
- .10 Vertical posts and horizontal railings of identical outside diameter.
- .11 Expansion sleeves at location of building expansion joints and at 8000 mm o.c. maximum spacing. Locate expansion sleeves within 300 mm of post.
- .12 Railing turned back to wall, floor or post at end of run.
- .13 Posts located maximum 150 mm each way from corner or point of change of direction. Space both posts equal distance from corner.
- .14 Welded aluminum end caps at railing terminations.
- .15 Continuous 150 mm high toe-board along open sides of platforms or landings.

- 
- .16 Unless noted otherwise, top rail not less than 1070 mm above the floor or platform on which it is installed. Top rail not less than 920 mm above the outside edges of stair nosing of exit stair.
  - .17 Intermediate rail midway between the top rail and floor or platform.
  - .18 Where possible, fit and shop assemble work ready for erection.
  - .19 Refer to contract drawing for additional details and requirements for handrails and posts.

**END OF SECTION**

**DIVISION 11  
EQUIPMENT**

## **Division 11 Equipment - Index**

*11000 General*

*11050 Process General Provisions*

*11216 Submersible Pumps*

**End of Section**

## 11000 General

### 1.0 General

#### 1.1 Order of Priority

- .1 The instructions given in this Section are to be given precedence with regard to Contract interpretation over the following sections within this Division.
- .2 Notwithstanding clause 1.1.1 above, instructions given Division 1 – General Requirements are to be given precedence with regard to Contract interpretation over those in this Division.

#### 1.2 Intent of Specifications

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.2.2 of this Section at no additional cost to the Owner except as allowed in the sole discretion of the Engineer.

#### 1.3 Engineer and Contract Administrator

- .1 In this Division, Engineer and Contract Administrator are deemed to have the same meaning.
- .2 The Engineer is as defined in the General Conditions section of this Contract.

#### 1.4 Submission of Alternate Proposals for Products or Materials

- .1 If the Contractor requests use of an alternate product or material then the Contractor is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract in accordance with Section 01035.
- .2 If an alternative product or material is accepted for use then the Contractor is responsible at their own cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .3 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.

#### 1.5 References to Standards

- .1 If references to standards appear in this Division, it is the intention of these Specifications to refer to the standard that was in effect at the time of the tender close for this Contract regardless of the date or version of the standard stated in the Division.

**End of Section**

## 11050 Process General Provisions

### 1.0 General

#### 1.1 Summary

- .1 Section includes supply, installation, testing and commissioning of mechanical equipment in Divisions 11 and 13 supplemented by details shown or specified in respective Sections. All costs associated with these services are to be included in the price(s) quoted.

#### 1.2 General Clauses

- .1 Comply with Division 1.
- .2 Unless there are more restrictive requirements in respective Sections, provisions of this Section apply.
- .3 Ensure that control panels and/or components provided as part of packaged equipment conform to requirements of the Specifications, Division 16 and Drawings.
- .4 For control and electrical elements, use this Section in conjunction with the Drawings for conformance to style, quality, and product demonstrated and selected. Provide instrumentation and control devices as detailed in the Specifications and shown on the Drawings, including Division 16.
- .5 All equipment and controls to be CSA compliant, and identified as such.
- .6 Comply with laws, ordinances, rules, regulations, codes, and orders of authorities having jurisdiction relating to work.
- .7 It is the Contractor's responsibility to ascertain from each Supplier the extent of work required for the complete installation of each piece of equipment, and to ensure that each Supplier has full knowledge of the required duty of the equipment to be installed.
- .8 Be fully acquainted with all work under this Contract. At no time will any claim be considered due to misunderstanding of the work involved.
- .9 Immediately upon receipt of the Start Work Order, issue a Purchase Order or Sub-Contract for designated equipment. Submit a copy of the Purchase Order or agreement to the Contract Administrator. Failure to order equipment in a timely fashion will not be considered as a reason to extend the Contract schedule.

#### 1.3 System Description

- .1 It is the intent of all Sections of these Specifications to specify a complete and operating system that will perform its intended function(s). All devices, fittings, valves and other appurtenances required to perform this function shall be considered as part of the Specifications, even if not explicitly identified.
- .2 Design requirements:
  - .1 Provide heavy-duty mechanical equipment designed for continuous operation.
  - .2 Maximum vibration velocity (measured at equipment bearings): 1 mm/s.
- .3 Co-ordination requirements:
  - .1 Equipment, such as pressure switches, may be shown on Process, Mechanical and/or Instrumentation Drawings. They may also be shown on Electrical Drawings

due to wiring requirements. Provide these devices under Division 11, 13, 14 and 15 respectively if included. Equipment and devices are wired according to the Electrical Drawings and Specifications.

- .2 Coordinate requirements of equipment supplied with piping, structural supports, ventilation/cooling, electrical service, instrumentation and control interface, and other ancillaries specified in other Divisions.

#### 1.4 Submittals

For all equipment supplied under this Division, the following submittals will be required, in accordance with Section 01300:

- .1 Shop drawings:
  - .1 Equipment layout including anchor bolt locations, direction of rotation for rotating equipment, and motor terminal box locations.
  - .2 Cross-sectional details of equipment with tests, materials list, and reference specifications (ASTM, CSA, CGSB, ANSI, etc.).
  - .3 Pumps: Certified, non-witnessed characteristic curves of head vs. flow, NPSH, efficiency, and power (kW). Information to include impeller model and diameter.
  - .4 Motors: Dimensioned drawings including motor and insulator ratings, full output power (kW), rpm and slip, start-up and operating current ratings, operating voltage, amperage tolerances, number of poles, motor nameplate details and motor test data.
  - .5 Instrument details.
  - .6 Control panel layouts.
  - .7 Required ancillary services, including but not limited to, electrical, non-potable water, and drains.
  - .8 Details of coating systems to be applied.
  - .9 Details of insulation provided to prevent galvanic corrosion between mating surfaces constructed of dissimilar metals, if such situation exists.
  - .10 Location of ancillary devices, conduit junction boxes, safety and control devices, and conduit entries for feeding or controlling equipment.
  - .11 Instrument loop diagrams, motor control schematics, and instrumentation and control schematics. For packaged equipment systems, submit appropriate drawings. Update information and maintain record drawing set until completion of work. Include computer/control programs, as applicable, for review as part of shop drawing submittal.
  - .12 Process flow diagrams and process and instrumentation diagrams (P&IDs) using ISA symbols for equipment that interfaces with instrumentation system or internal control loops.
  - .13 Detailed list of all equipment and components, including options that are proposed to be supplied for each Section.
- .2 Test reports, forms, and certificates:
  - .1 Start-up instructions including lubricant requirements, electrical requirements, and other similar items.
  - .2 Certification that for equipment equal to or exceeding 15 kW, anchor bolt calculations indicating adequacy of bolt sizing and anchor embedment have been performed and signed by Structural Engineer licensed in Province of Ontario.
  - .3 Certified shop mechanical test results for fans with capacity of 10 m<sup>3</sup>/s and larger or motors 37 kW and larger.

- .4 Certified pump shop test results.
- .5 Certified electric motor shop test results.
- .6 Other certified equipment shop test results, where specified in respective Sections.
- .7 Completed Manufacturers Installation Certification Form 11050-A.
- .8 Completed Pre-Commissioning Certification Form 11050-B.
- .3 Installation, operation and maintenance manuals:
  - .1 In accordance with Section 01300 and 01730.

## 1.5 Quality Assurance

- .1 Standards:
  - .1 AFBMA Std 9, Load Ratings and Fatigue Life for Ball Bearings.
  - .2 AFBMA Std 11, Load Ratings and Fatigue Life for Roller Bearings.
  - .3 ANSI/ASME, Boiler and Pressure Vessel Code, Section VIII, Division 1.
  - .4 ANSI B1.1, Unified Screw Threads.
  - .5 ANSI B1.20.1, Pipe Threads, General Purpose.
  - .6 ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250 and 800.
  - .7 ANSI B16.5, Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy and Other Special Alloys.
  - .8 ANSI B18.2.1, Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws, and Log Screws.
  - .9 ANSI B18.2.2, Square and Hex Nuts.
  - .10 ANSI/ASME B31.1, Power Piping.
  - .11 ANSI/ASME B31.3, Chemical Piping.
  - .12 ANSI/ASME B31.9, Building Services Piping.
  - .13 ANSI B32.1, Metal Products.
  - .14 ANSI B46.1, Surface Texture.
  - .15 ANSI/ASME B1.20.1, General Purpose Pipe Threads.
  - .16 ASTM A 48, Specification for Gray Iron Castings.
  - .17 ASTM A307, Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
  - .18 ASTM A320, Alloy-Steel Bolting Materials for Low Temperature Service.
  - .19 CSA CAN3-S16.1-M, Steel Structures for Buildings (Limit State Design).
  - .20 CSA C59-M, Welded Steel Construction (Metal Arch Welding).
  - .21 CSA S244, Welded Aluminum Design and workmanship (Inert Gas Shielded Arch Processes).
  - .22 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
  - .23 CSA W47.22-M, Certification of Companies for Fusion Welding of Aluminum.
  - .24 Canadian Electrical Code (CEC), Safety Standard for Electrical Installations.
  - .25 CGA B105, Canadian Gas Association (CGA) Installation Code for Digester Gas Systems.
- .2 Certificates:
  - .1 Shop finished metal: Certify that shop finished metal components received specified protective coating system.

- .2 Welding aluminium: Certify that companies welding aluminum components are CSA-approved.

## **1.6 Services of Manufacturer**

- .1 Provide the following minimum services of the manufacturer for inspection, start-up, and field adjustment unless otherwise specified:
  - .1 One visit concurrent with installation of equipment.
  - .2 One visit for start-up and field testing for proper operation of equipment. Perform field adjustment to ensure equipment and operation complies with Specifications.
  - .3 Allow one (1) full working day on site per visit.

## **1.7 Training**

- .1 Provide training to Owner in accordance with Section 01650.

## **1.8 Factory Testing**

- .1 Provide the following services for factory testing, unless otherwise indicated:
  - .1 Test product at factory for compliance with specified requirements.
  - .2 Statically and dynamically balance rotating elements of equipment at factory prior to final assembly to provide smooth operation. Provide Contract Administrator with 10 business days advance notice of factory test.
  - .3 Contract Administrator may witness factory test.
  - .4 Do not deliver equipment to site until equipment has met specific requirements of factory tests.

## **1.9 Product Delivery, Storage and Handling**

- .1 Unless otherwise indicated in the respective Sections, the Contractor is to be responsible for unloading any equipment upon delivery to site. Unloading to be done carefully and according to the Manufacturer's recommended practices.
- .2 Deliver, store and handle equipment in accordance with Section 01600 and the following additional requirements:
  - .1 Deliver material to site in original, unbroken packages, containers or bundles bearing name of manufacturer.
  - .2 Box, crate or otherwise protect equipment from damage and moisture during shipping, handling and storage.
  - .3 Protect bearings, seals and glands from grit and foreign matter.
  - .4 Protect equipment from exposure to corrosive fumes.
  - .5 Arrange for delivery of equipment to site to meet applicable dates in progress schedule.
  - .6 Arrange for delivery of anchor bolts, templates, embedded miscellaneous metals, and other similar items to site as required during construction.
  - .7 Do not arrange for delivery to site of equipment until suitable storage space exists within the storage facility on site so that equipment can be protected from weather, construction debris, and dust.
  - .8 Keep equipment dry at all times.
  - .9 Store equipment at site prior to installation in temporary weathertight, heated storage facilities free from dust, moisture, and other conditions that could damage equipment.

- .10 Do not use plastic wrappers to prevent accumulation of condensate in gears and bearings, if equipment is stored for extended period.
- .11 Remove rejected equipment damaged during shipment, storage or installation and replace with new identical equipment.
- .12 Improperly stored equipment will be rejected from site.

#### **1.10 Special Tools**

- .1 Provide one complete set of special tools recommended by manufacturer for maintenance and repair of each separate type of equipment.
- .2 Store special tools in tool boxes.
- .3 Identify tool box with equipment number with stainless steel or solid plastic name tags attached to box.

#### **1.11 Spare Parts**

- .1 Provide spare parts recommended by manufacturer with equipment where specified in respective Sections.
- .2 Include in any submittals a list of the Manufacturer's recommended spare parts.
- .3 Tag spare parts by Project equipment number and identified as to part number, equipment manufacturer and sub-assembly component (if appropriate).
- .4 Protect spare parts subject to deterioration such as ferrous metal items and electrical components with lubricants or desiccants. Encapsulate spare parts in hermetically sealed plastic wrapping.
- .5 Store spare parts in wooden boxes with hinged cover and locking hasp if spare part weighs less than 50 pounds. Provide strap type hinges. Paint and identify box with stencilled lettering stating name of equipment, equipment numbers and words "Spare Parts". Provide neatly typed inventory of spare parts on underside of cover.

#### **1.12 Unit Responsibility**

- .1 Provide equipment systems comprised of two or more components as unit by responsible manufacturer. Unless otherwise specified, responsible manufacturer to be supplier of driven unit.
- .2 Choose and assemble components of equipment system to enhance compatibility, ease of construction, and efficient maintenance.

#### **1.13 Alternatives**

- .1 This is a BASE BID specification. The Contractor shall base his tender price on quotations received from the equipment suppliers as hereinafter specified, unless otherwise noted.
- .2 **See also Division 1, Section 01600, Clause 1.4 and Section 01035 for Alternative Equipment.**

### **2.0 Products**

#### **2.1 General**

- .1 Provide equipment as follows:
  - .1 Specified products meeting specified requirements.

- .2 New products from current and specified manufacturer.
- .3 Suitable for intended purposes, of high quality and free of defects.
- .4 Equipment to operate at highest efficiency possible for that equipment type.
- .5 Products and materials recommended by specified manufacturer for intended service.
- .6 All working parts to be standard sizes such that parts will be interchangeable between like units and that the Owner be able to obtain replacement and repair parts at any time in the future.

## 2.2 Equipment General Requirements

- .1 Provide equipment designed for:
  - .1 Service factor: Use minimum service factor of 1.25 in selection and design of mechanical power transmission components unless otherwise specified in various Sections.
  - .2 Welding procedure for stainless steel piping: To Division 15.
  - .3 Welding procedure for equipment: ANSI/AWWA D100 and AWWA C206.
  - .4 Equipment identification: Legible identifying mark corresponding to equipment number indicated.
  - .5 Shop fabrication: In accordance with shop drawings.
  - .6 Tolerances: Maximum variation in length of members without machine finished ends that are framed is 1.59 mm for members 9.1 m or less, maximum 3.175 mm for members over 9.1 m in length.

## 2.3 Bearings

- .1 Bearings for rotating equipment:
  - .1 Design: B-10 life expectancy to Anti-Friction Bearing Manufacturers Association Inc. (AFBMA) at rated conditions of service for minimum 100,000 working hours, unless otherwise specified.
  - .2 Grease fittings for bearing lubrication.
  - .3 Bearing selection based on following criteria: Fitting practice, mounting, lubrication, sealing, static rating, and housing strength.
  - .4 Lubricated-for-life bearings: Factory lubricate with manufacturer's best recommended grease to insure maximum bearing life and best performance.
  - .5 Re-lubricatable type bearings: Grease nipple for loading and capped vent to relieve aged grease.
  - .6 Equip oil lubricated bearings with either pressure lubricating system or separate oil reservoir type system.
  - .7 Design oil lubrication systems of sufficient size to absorb heat energy generated in bearing under maximum ambient temperature of 40°C. Provide filler pipe and external level indicator gauge.
  - .8 Bearing housings: Cast iron or steel, unless otherwise specified.
  - .9 Bearing mounting arrangement: to published standards of manufacturer.
  - .10 Electric motors: Design bearings so no grease or oil can escape.

## 2.4 Shafting

- .1 Continuous shafting between bearings.

- .2 Size shafting to transmit power required.
- .3 Provide keyways in accordance with manufacturer's standard practice.
- .4 Select materials for shafting for type of service, torque transmitted, and effect of corrosive gases, moisture, and fluids used in service.
- .5 Materials:
  - .1 Low carbon cold-rolled steel shafting: ASTM A 108, Grade 1018.
  - .2 Medium carbon cold-rolled shafting: ASTM A 108, Grade 1045.
  - .3 Corrosion resistant shafting: stainless steel or Monel, whichever is most suitable for service.

## **2.5 Equipment Guards**

- .1 All equipment to be guarded in compliance with Ontario Health and Safety Act (OHSA) requirements and any other applicable regulations.
- .2 Without limiting clause 2.5.1 above, provide equipment guards for couplings, belts, chain drives, extended shafts, and exposed moving or rotating parts:
  - .1 Securely mounted guards.
  - .2 Reinforced, minimum 2.8 mm thick sheet steel or expanded sheet metal.
  - .3 Smooth edges and corners with borders neatly welded to perforated sheet.
  - .4 Hinged and latched access doors.
  - .5 Hot-dip galvanize steel guards after fabrication.
  - .6 Guards designed to totally enclose couplings, belts, chain drives, extended shafts, and exposed moving or rotating parts.
  - .7 Paint guards to same standard as parent equipment.
  - .8 Removable type guards to facilitate maintenance of moving parts.
  - .9 Make provision to extend grease fittings through guards.

## **2.6 Caution Signs**

- .1 Use vinyl stick-on type decals placed onto clean, smooth surface of equipment to be posted.
- .2 Where insufficient space exists, use decal applied to galvanized mild steel, fibreglass, or plastic sheet fastened to equipment.
- .3 Provide signs that read "CAUTION - AUTOMATIC EQUIPMENT MAY START AT ANY TIME".
- .4 Letters: 25 mm in height, red, on yellow background.
- .5 Mounting posts and hardware. Mount close to guarded moving parts.
- .6 Sufficiently sized taps to avoid plugging and to permit instruments to be installed.

## **2.7 Equipment Noise Levels**

- .1 Design equipment for quiet operation.
- .2 Overall noise level at equipment to be maximum 85 decibels measured on "A" weighting network using survey and field methods conforming to ANSI S1.13 and CSA Z107.2, unless otherwise specified.
- .3 If hearing protection is required, Contractor shall install signs as directed at each door entering the area where hearing protection is required.

## **2.8 Equipment Identification**

- .1 Nameplates for equipment:
  - .1 Securely attached in suitable location.
  - .2 Nameplate material: Corrosion-resistant metal.
  - .3 Impressed type lettering on equipment.
  - .4 Provide a minimum of the following information on nameplate (units to be metric):
    - .1 Model number.
    - .2 Serial number.
    - .3 Capacities.
    - .4 Efficiency.
    - .5 Brake horsepower.
    - .6 Other information required to uniquely identify equipment.

## **2.9 Electrical Control and Instrumentation**

- .1 Provide CSA approved instrumentation, control, and electrical devices that bear CSA approvals sticker.

## **2.10 Pilot Devices**

- .1 Electrical pilot devices including switches, relays, and contacts: Use heavy-duty industrial quality devices in accordance with the specifications and Electrical Drawings.
- .2 Contacts that provide alarm, malfunction or control to external systems must be rated for minimum 10 Amps continuous at 120 Volts AC, except for pressure switches and temperature switches rated minimum 5 Amps continuous at 120 Volts AC.

## **2.11 Indicating Lights**

- .1 Use oil-tight transformer type indicating lights with low voltage lamps and push-to-test features, with coloured lenses in accordance with the specifications and Electrical Drawings.

## **2.12 Disconnect Switches**

- .1 Disconnect switches in accordance with the specifications and Electrical Drawings.

## **2.13 Cables**

- .1 Cables in accordance with the specifications and Electrical Drawings.

## **2.14 Conduits**

- .1 Conduits, conduit fastenings, and fittings in accordance with the specifications and Electrical Drawings.

## **2.15 Grounding**

- .1 Grounding in accordance with the specifications and Electrical Drawings.

## **2.16 Programming**

- .1 All computer/control programs required for the intended operation of supplied equipment, as designed and as shown on the Contract Drawings and in the Specifications, shall be considered an essential component of that equipment. Such programs are to be delivered as

part of the shop drawing review, and no delivery of equipment shall occur until all required programs have been approved by the Contract Administrator.

### **3.0 EXECUTION**

#### **3.1 Finishes**

- .1 Finish equipment to following quality:
  - .1 Welds: free of slag, ground and buffed.
  - .2 Surfaces of castings: ground smooth.
  - .3 Corners and edges on sheet metal work: rounded.
  - .4 Materials and equipment: free of dents.
  - .5 Machined surfaces finished: to specified tolerances.

#### **3.2 Painting**

- .1 Equipment shall be factory painted.

#### **3.3 Equipment Installation - General**

- .1 Install equipment components as follows:
  - .1 Couplings: To manufacturer's and onsite representative's installation instructions.
  - .2 Insulating connections: To manufacturer's installation instructions.
  - .3 Packaged equipment: Co-ordinate space and structural requirements, clearance, utility connections, signals, outputs and features required by manufacturer including safety interlocks.

#### **3.4 Equipment Preparation**

- .1 Prior to equipment installation, inspect and field measure to ensure that previous work is not prejudicial to successful installation of equipment.
- .2 Provide required notices, submit drawings, obtain permits, licenses and certificates and pay fees required for work.
- .3 Make minor modifications to suit piping and other installed equipment and structural element locations and elevations.

#### **3.5 Equipment Installation**

- .1 Provide labour and materials to install equipment.
- .2 Install equipment at locations indicated on Drawings.
- .3 Minimum installation standards: To manufacturer's written instructions and in accordance with shop drawings.
- .4 Install piping and miscellaneous items supplied as part of equipment including sensors and wiring, lubrication piping, pressure gauge tubing, pressure gauges, pressure switches, transmitters, pneumatic valve operator tubing, and other similar items.
- .5 Dimensions where shown in Drawings for equipment bases, piping connections, and similar items are approximate and must be allowed for in installation of equipment to suit actual equipment supplied.

- .6 Make necessary modifications to piping connections or to pipe work to suit equipment supplied.
- .7 Use only new bolts, nuts and gaskets for any pipe joint or mechanical connection that is made during the installation/re-installation of any equipment.
- .8 Place equipment base template at appropriate location.
- .9 Supply necessary shims, gaskets and other similar items and necessary lifting and loading equipment and tools required to complete installation.
- .10 Level equipment using stainless steel shims. Levelling nuts are not allowed.
- .11 Where equipment is supplied with plate steel base, provide access holes in top of plate and grout base in accordance with Section 03610. Neatly form, bevel, and trim finished grout.
- .12 Refer to manufacturers' recommendations included in shop drawing submittal to determine sequence of installation.
- .13 Demonstrate final alignment (hot or cold as applicable) to Contract Administrator and manufacturer, with no soft foot and no pipe strain.
- .14 Lubrication:
  - .1 Extend inaccessible lubrication points and lubricant drains to convenient locations.
  - .2 Remove storage lubricant and provide initial fill of new lubricants for equipment.
  - .3 Lubricant grade as recommended by equipment manufacturer.
- .15 On machined bases without shims: provide minimum 1.5 mm brass shim stock under drive.
- .16 Install equipment on foundation with suitably sized anchor bolts. Ensure true alignment of parts, especially pumps and drives.
- .17 Install equipment level and plumb. Use of "pipe springing" and "Dutchmen" to correct misalignment and misfitting is not permitted.

### **3.6 Equipment Alignment**

- .1 Align equipment after plates are shimmed at anchor bolts.
- .2 Recheck alignment after securing equipment to foundation before grouting plates in place.
- .3 Recheck alignment of equipment handling hot fluids during initial operation.

### **3.7 Equipment Field Tests**

- .1 Field Test equipment for compliance with Specifications.
- .2 Field test in accordance with Section 01680.
- .3 Provide advance notice of tests to Contract Administrator as specified in Section 01680.
- .4 Contract Administrator may witness field tests.
- .5 Calibrate, test, start-up, adjust, and commission equipment in accordance with manufacturer's written instructions and under supervision of equipment manufacturer if specified under respective Sections.
- .6 Include in inspection:
  - .1 Soundness (without cracked or otherwise damaged parts).
  - .2 Completeness of installation as specified and as recommended by manufacturer.
  - .3 Correctness of settings, alignment and relative arrangement of various parts of system.

- .7 Check controls and safety devices.
- .8 Check equipment is level and drive is aligned.
- .9 Modify or replace equipment failing tests.
- .10 Perform additional tests due to material changes requested by Supplier that were approved by Contract Administrator or due to failure of materials of construction to meet Specifications.
- .11 Provide copies of manufacturer's site report to Contract Administrator in accordance with requirements of Section 01680.
- .12 Manufacturer's report to include:
  - .1 Description of inspection, tests, adjustments made, quantitative results and suggestions for precautions to be taken to ensure proper maintenance.
  - .2 Verification that equipment conforms to Specifications for service intended and is ready for permanent operation.
- .13 Equipment will be accepted after successful start-up and receipt of manufacturer's report.

### **3.8 Guarantees and Warranty**

- .1 Unless otherwise indicated in the specific Sections contained herein, all equipment and services supplied under this Division shall be guaranteed by the Contractor to be free from all defects, in manufacture or installation, and wear for a period of at least one (1) year from the date of Substantial Completion.
- .2 This guarantee will allow for the repair or replacement of improperly operating equipment at the Owner's discretion. The Contractor shall provide temporary equipment of equal capacity for the duration of any period in which the equipment is non-functional at no additional cost to the Owner.
- .3 The length of this warranty period shall be extended to one (1) year from the date that any repaired or replaced equipment is returned to service, for that equipment only.
- .4 If the Contractor obtains a guarantee from the Manufacturer, the signature of an authorized representative of the Manufacturer must accompany that guarantee.

### **3.9 Forms**

- .1 Forms listed below are attached, following this Section:
- .2 11050-A, Manufacturer's Installation Certification Form.
- .3 11050-B, Pre-Commissioning Certification Form.

**End of Section**

**11050-A. MANUFACTURER’S INSTALLATION CERTIFICATION FORM:**

Contract No: \_\_\_\_\_ Specification Section: \_\_\_\_\_

Equipment name: \_\_\_\_\_

Contractor: \_\_\_\_\_

Manufacturer of equipment item: \_\_\_\_\_

The undersigned manufacturer of the equipment item described above hereby certifies that a qualified individual has checked the installation of the equipment and that the equipment, as specified in the Contract Documents, has been provided in accordance with the manufacturers recommendations and that the trial operation of the equipment item has been satisfactory.

Comments: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
Date

\_\_\_\_\_  
Manufacturer

\_\_\_\_\_  
Signature of Authorized Representative

\_\_\_\_\_  
Date

\_\_\_\_\_  
Contractor

\_\_\_\_\_  
Signature of Authorized Representative

**11050-B. PRE-COMMISSIONING CERTIFICATION FORM**

Contract Name: \_\_\_\_\_ Contract No.: \_\_\_\_\_

Process System Name: \_\_\_\_\_

List each equipment item included in the process system. Attach marked Piping Schematics and/or P&ID indicating specific items and system limits.

Equipment Name (Including Item No.)	Equipment No.	Manufacturer

The Contractor certifies that operational testing of the process system is complete and that the process system has been cleaned and made ready for commissioning.

The contractor hereby transfers operation and maintenance of the process system to the Owner for commissioning. This transfer does not relieve the Contractor of any contractual obligation to the Owner. The Contractor will assist the Owner and provide required support during commissioning as specified in Division 1.

This document is not to be construed as Substantial Completion or Notice of Acceptance.

**Request for Transfer**

\_\_\_\_\_  
Contractor                                      Signature of Authorized Representative                                      Date

**Acceptance of Transfer**

\_\_\_\_\_  
Owner    Signature of Authorized Representative    Date

## 11216 Submersible Pumps

### 1.0 General

#### 1.1 Description

- .1 This Section covers the supply, installation and commissioning of submersible pumps complete with drive and other accessories as specified herein and shown on the drawings.

#### 1.2 Related Work Specified Elsewhere

- |    |             |                      |
|----|-------------|----------------------|
| .1 | Division 1  | General Requirements |
| .2 | Division 3  | Concrete             |
| .3 | Division 9  | Painting             |
| .4 | Division 15 | Mechanical           |
| .5 | Division 16 | Electrical           |

#### 1.3 Dimensions

- .1 Prior to ordering materials and proceeding with the work, check and confirm that the dimensions indicated on drawings agree with the dimensions of equipment specified.
- .2 Notify Contract Administrator of any discrepancy in dimensions and obtain clarification. Correct the dimensions as instructed.

#### 1.4 Reference Standards

- .1 Pumping units shall generally comply with the requirements of the following Standards:
  - .1 American Gear Manufacturing Association (AGMA)
  - .2 American Institute of Steel construction (AISC)
  - .3 American Iron and Steel Institute (AISI)
  - .4 American Society of Mechanical Engineers (ASME)
  - .5 American National Standards Institute (ANSI)
  - .6 American Society for Testing Materials (ASTM)
  - .7 American Water Works Association (AWWA)
  - .8 American Welding Society (AWS)
  - .9 Anti-Friction Bearing MANUFACTURERS Association (AFBMA)
  - .10 Hydraulic Institute Standards
  - .11 Institute of Electrical and Electronics Engineers (IEEE)
  - .12 National Electrical Code (NEC)
  - .13 National Electrical MANUFACTURERS Association (NEMA)
  - .14 Occupational Safety and Health Administration (OSHA)
  - .15 Steel Structures Painting Council (SSPC)
  - .16 Underwriters Laboratories, Inc. (UL/ULC)
  - .17 Canadian Standards Association (CSA)

- .18 NFPA 820, Fire Protection in Wastewater Treatment and Collection Facilities, latest edition.
- .2 Pumping unit(s) wiring and motor shall conform to Division 16 except as listed herein.

**1.5 Submittals**

- .1 Submit shop drawings, manuals, parts lists, etc. in accordance with Sections 01300 and 01730.
- .2 Submit certified pump curves from Manufacturer indicating relationship between speed, capacity, head, power and efficiency. Indicate design operating point on curve.
- .3 Testing:
  - .1 Submit field test reports in accordance with Sections 01680 and 11050.
  - .2 Submit completed Manufacturer’s Installation Certification Form specified in Section 11050.
  - .3 Submit completed Pre-Commissioning Certification Form specified in Section 11050.
- .4 Installation, operation, and maintenance manuals:
  - .1 Include material under this Section in Owner’s manuals in accordance with Sections 01730 and 11050.

**2.0 PRODUCTS**

**2.1 Design Criteria**

- .1 The Contractor shall furnish and install submersible pumps suitable for the application and duties given in Table 11216-1 below using Hydraulic Institute standards Level A (HIA). Provide unit possessing as high efficiency as possible when continuously operating at the design point and in the maximum efficiency range.

**Table 11216-1**

Location	Tag No.	Media	No. of Units	Capacity (L/s)	Rated Head (m)	Model (Xylem)	Impeller (mm)	Power (kW)
RWW-101	RSP-01	Raw Sewage	1	Single Operating Point (60Hz): 44.93	24.57 m	NP-3171 HT3~455	256	18.6
RWW-102	RSP-02	Raw Sewage	1	Single Operating Point (60Hz): 44.93	24.57 m	NP-3171 HT3~455	256	18.6

- .2 The duty pump(s) shall be close coupled to a 600VAC/3 Ph/60 Hz submersible motor suitable for continuous operation at any point on the performance curve without exceeding the nameplate rating of the motor .

- .3 Pump(s) to be complete with thermistors, leak detector, composite cable and all necessary guide bar holders, discharging elbow, stainless steel chain and all other equipment required to complete the installation to the intent of the Drawings.
- .4 Pumps to be supplied with complete system for removing pump from wet well (up to but excluding hoists supplied under Division 14).
- .5 Submersible pumps to be suitable for use in a municipal wastewater pumping application, with area classification and duty requirements as shown in Table 11216-2.

**Table 11216-2**

Tag	Classification	Duty Requirements
RSP	Class 1, Division 1	Up to 12 starts per hour

**2.2 Pump Construction**

- .1 Pump casing shall be constructed of cast iron conforming to ASTM A48, Class 40B. Impellers shall be of Hard-Iron (60 HRC). Shafts shall be of carbon steel conforming to ASTM A276, Type 420. Exposed nuts and bolts to be stainless steel, including anchor bolts.
- .2 The pumps shall be totally submersible, with common motor and pump shaft. Enclose the vertically mounted electric motor in a watertight casing mounted directly on the pump casing.
- .3 Provide pumps of non-clog construction with impeller keyed or otherwise positively locked to the shaft by means of lock pin, lock nut or combination of these. Impellers to be suitable for sewage and sludge in a municipal application and acceptable to MOE Guidelines.

**2.3 Bearings**

- .1 The integral pump/motor(s) shall rotate on two (2) bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a single roller type bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum B-10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

**2.4 Mechanical Seals**

- .1 The pump(s) shall be provided with a positively driven dual, tandem mechanical shaft seal system consisting of two (2) seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one (1) stationary and one (1) positively driven rotating corrosion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber, shall contain one (1) stationary and one (1) positively driven rotating corrosion resistant tungsten-carbide seal ring. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing. Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

**2.5 Spin-Out™**

- .1 The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing

abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

## 2.6 Protection

- .1 NP3171 pumps:
  - .1 The pump(s) motor stator shall incorporate three (3) thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signalling the need to schedule an inspection.
  - .2 Provide multi-function control and monitoring relays for connection of the thermal and leakage (float) switches for each new pump, MiniCas II by ITT Flygt, or approved equal for the pumps indicated in Table 11216-1. Relays are to be complete with door mounted clips and relay bases.
- .2 Provide one (1) spare additional relay for spare.
- .3 Free issue relays to MCC manufacturer.

## 2.7 Pump Design

- .1 The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two (2) guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal, watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

## 2.8 Pump Hardware

- .1 Provide hoisting chain of galvanized steel, and of sufficient length to be attached to the pump(s) and to a point near the pump(s) access hatch, to be easily reached by a worker beside the opening.
- .2 Notwithstanding the above, hoisting chain to be supplied in accordance with the pump removal system proposed, subject to Contract Administrator approval. Chain-sling and grip eye to be supplied with pumps and bracket for holding each lifting chain accessible from pump hatch.

## 2.9 Motors

- .1 Provide motors in accordance with Division 16. Motors for these pumps are to be provided as standard efficiency.
- .2 Pump(s) and motor(s) to be suitable for use in areas classified as shown in Table 11216-2.
- .3 Provide motor(s) and pump(s) suitable for continuous operation without overheating when the pump volute only is submerged.
- .4 Provide VFD rated motor(s) as described on the P&I and Electrical drawings.

## 2.10 Cable Entry Seal

- .1 The cable entry seal design shall preclude specific torque requirements to ensure a watertight and submersible seal. The cable entry shall consist of a single, cylindrical elastomer

grommet, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter and compressed by the body containing a strain relief function, separate from the function of sealing the cable. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be separated by a stator lead sealing gland or terminal board, which shall isolate the interior from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.

## **2.11 Mounting Platform**

- .1 A mounting bracket as shown in the Contract Drawings for each raw sewage pump shall be provided under this Section.
- .2 Stand to be designed and stamped by a Professional Engineer licenced in the Province of Ontario. Design to be signed off by the pump Supplier.
- .3 Mounting bracket to be constructed of Cast Iron.
- .4 Mounting platform to be free-standing and secured to the wetwell floor using Hilti HY150 anchors or approved equal. Some form of bracing to the wetwell side slope is acceptable, subject to approval of Contract Administrator. Drawings are representative only, and the responsibility for stand design rests with the stamping Engineer.
- .5 Include mounting platform details with shop drawing submittal.

## **2.12 Accessories**

- .1 Include One (1) Flygt Flush Valve with installation.
  - .1 Model Type 4901.

## **2.13 Spare Parts**

- .1 Supply one (1) complete set of spare parts as recommended by the manufacturer, but include at a minimum:
  - .1 One (1) set of seals/bearings; and
  - .2 One (1) spare impeller.

## **2.14 Approved Manufacturers**

- .1 Base Design Manufacturer
  - .1 Xylem (formerly ITT Flygt) – Model number as noted in 2.1 of this Specification.
- .2 Reviewed Alternate Manufacturers
  - .1 ABS - Sulzer
- .3 The process and facility design was based on information supplied by the named “Base Design Manufacturer” equipment. “Reviewed Alternate Manufacturers” were listed based on the perception that they could meet the process performance and represented acceptable technologies. However, “Reviewed Alternate Manufacturers” were not reviewed based on process hydraulics, performance, physical layout, accessibility, piping and/or electrical requirements. The equipment manufacturer/supplier and the contractor shall therefore be responsible for verifying that the “Reviewed Alternate Manufacturers” meets the hydraulic profile and performance requirements, and make all structural, building, piping, electrical, instrumentation and control alterations required at no additional cost to the owner / contract including assessing impacts on the generator sizing, if any, noting that any change would

require a further ECA amendment which would not be accepted. All information and alteration shall be submitted to the Engineer for approval.

- .4 Reviewed and Non-Reviewed Alternate Manufacturers will be reviewed after the award of the contract as per Section 01035 of this specification document.
- .5 The naming of a manufacturer in this specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified.

### **3.0 EXECUTION**

#### **3.1 Shop and Field Testing**

- .1 Shop and field testing to be done in accordance with Section 01680.
- .2 Field test all pumps in presence of the Contract Administrator to demonstrate that the installation is correctly completed and each pump is operating satisfactorily without vibration or cavitation.
- .3 All field tests must be supervised by pump manufacturer's representative.
- .4 Contract Administrator requires 72 working hours written notice prior to such tests.
- .5 The Contractor shall supply all required metering devices and gauges necessary to demonstrate pump performance. Supply and install gauge connections as required.
- .6 Test results must be properly documented and presented to the Contract Administrator.

#### **3.2 Installation**

- .1 Install equipment and accessories in accordance with the manufacturer's recommendations and to the satisfaction of the Contract Administrator, 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 required for the specified operation of the equipment.

#### **3.3 Commissioning and Certification**

- .1 Provide a qualified technical representative of the equipment supplier for a minimum of one (1) day to supervise the commissioning of the equipment.
- .2 Operate equipment for at least one (1) hour to demonstrate operations of the equipment and controls over several cycles, and take necessary remedial steps to ensure satisfactory operations.
- .3 Arrange for the Contract Administrator and the Owner's representatives to be present at the time of commissioning.
- .4 Demonstrate that all the equipment is installed properly and is performing satisfactorily.
- .5 Obtain a certificate from the supplier stating that his qualified representative has found the installation to be to his satisfaction. Submit the certificate to the Contract Administrator.
- .6 The manufacturer shall provide a Certificate of Installation to the Contract Administrator in accordance with Sections 11050, 01650 and 01680 when the equipment has been satisfactorily installed.

### **3.4 Training Provided by Manufacturer**

- .1 Provide services of authorized manufacturer for one (1) day training session for the equipment and accessories specified under this section to train Owner's staff.

### **3.5 Painting**

- .1 Equipment shall arrive on site painted and ready for installation.
- .2 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. Prior to the final paint finish being applied, the pump components shall be primed and washed. The components shall then be assembled and washed a second time before the final topcoat is applied. The finish paint or top-coat shall be Flygt Duasolid, or approved equal, applied externally to a minimum dry film thickness of not less than 100 (microns). The film thickness shall be consistent with ISO 2808, method no. 6.
- .3 Discharge assembly shall be suitably protected against corrosion as above due to constant submergence.

**End of Section**

**DIVISION 13  
SPECIAL CONSTRUCTION**

**Division 13 Special Construction - Index**

*13006 Maintaining Plant Operation*

**End of Section**

## 13006 Maintaining Plant Operation

### 1.0 General

#### 1.1 Description

- .1 This Section covers the supply, installation and commissioning of submersible pumps complete with drive and other accessories as specified herein and shown on the drawings.
- .2 Supply, installation and maintenance of temporary bypass pumps and piping to permit work in the downstream wet well.
- .3 Requirements for planning, scheduling and carrying out construction activities to avoid interference with the operation of the sewage pumping station.
- .4 The work generally consists of that described in Section 01010.
- .5 Timing, planning, staging and co-ordination of work **is of critical importance** and must take into account the following constraints and conditions.
- .6 Construction activities to be carried out to minimize interference with pumping station's operations which takes place on a continuous basis.
- .7 Safe vehicle and access by Owner's operating staff must be provided at all times to existing traffic access areas.
- .8 Temporary construction fencing must be erected around the construction site.
- .9 Maintain operation of the existing station at all times, and do not interfere with any aspect of its operation.
- .10 Maintain backup generator supply at all times during construction.
- .11 Coordinate electrical, instrumentation and control upgrades and expansions so as not to interfere with existing plant operations.

#### 1.2 Related Work

- |    |             |                 |
|----|-------------|-----------------|
| .1 | Division 1  | In its entirety |
| .2 | Division 11 | In its entirety |
| .3 | Division 15 | In its entirety |
| .4 | Division 16 | In its entirety |

#### 1.3 Pumping Station Operation

- .1 For every portion of work that will affect the normal operations for the pumping station, make a written request to carry out the work indicating which facilities will be affected, why the work cannot be carried out without affecting the operation and the length of time required for the work. Submit request to Contract Administrator a minimum of ten (10) working days in advance of when the work is required.
- .2 Contractor's work forces are not permitted to operate any existing equipment, valve or other control device. If existing equipment must be operated, contact the Owner.
- .3 Accept responsibility for all damages and liabilities resulting from unauthorized operation of any equipment, valve or other devices.

- .4 Bear all costs associated with corrective action necessary to overcome emergencies resulting from neglectfully or careless acts by the Contractor. This includes not maintaining rental equipment in "ready to run" order.
- .5 Additional work associated with operation of the pumping station may be in progress throughout the duration of the Contract, and the Contractor shall co-operate with operating personnel and allow free access to their work at all times. The Contract Administrator reserves the right to alter the method of operations on this Contract to avoid interference with other work.

#### **1.4 Temporary Bypass Pumping and Piping**

- .1 Install temporary by-pass pumping during low flow conditions, and only when all equipment required for the submersible pump replacement (including but not limited to pumps, rails, valves, piping) is present on site. The new electrical service and generator should also be in place. The new valve chamber should be installed and ready for final tie-ins at this point. The intent is to minimize the duration of temporary pumping to the extent possible.
- .2 The Contractor will need to schedule this work during low flow conditions and request clearance from the Municipality and OCWA ten (10) days in advance with daily updates each day starting five (5) days ahead of the work. Average daily flow rate is approximately 1.5L/s, and peak hour flow through the existing forcemain is approximately 10L/s. Bypass pumping from the upstream manhole to the existing valve chamber to be provide complete with valving as indicted on the drawings, which is provided for general convenience. Piping to be supported/restrained as may be required.
- .3 Temporary pumping systems to include, at a minimum:
  - .1 Two (2) pumps, each rated at approximately 10 L/s at 9m TDH, and configured in duty/standby mode.
  - .2 Fuel Type: Diesel
  - .3 Maintenance Requirements: Based on provider, to be included in the Contractors bid.
  - .4 Alarm monitoring: Field Smart Technology or equivalent
  - .5 Heat tracing to be provided subject to time of year use
- .4 Once temporary pumps and piping are deemed operational, Contractor to install temporary plug on 200mm diameter interconnecting the manhole and wet well.
- .5 Temporary pumping and bypass system to remain in place until such time that the new submersible pumps and related works are commissioned successfully.

#### **1.5 Protection of Existing Structures, Services and Facilities**

- .1 Plan and carry out all construction activities in a manner to prevent damage to existing structures, services and facilities.
- .2 Accept responsibility for and repair existing structures, services and equipment that are damaged by construction activities.
- .3 Take all measures and provide all facilities necessary to prevent exposure of equipment to dust, fumes and excess moisture.
- .4 Perform all construction activities in a manner to avoid creation or migration of dust, excess moisture and fumes. Provide temporary ventilation facilities where required to control dust and fumes which may damage the operation of existing equipment and controls.
- .5 Provide additional ventilation of the area as required, in event that existing heating and ventilating system is inadequate.

- .6 Isolate all activities that create dust, excess moisture and fumes by constructing suitable temporary enclosures or by some other form of protection acceptable to the Contract Administrator.
- .7 It is essential that dust, moisture and fumes be strictly controlled to prevent damage to equipment and to sensitive electrical instruments and control systems.

**1.6 Schedule**

- .1 Submit to the Contract Administrator for approval, a Schedule of Construction in accordance with the requirements of the General Conditions.
- .2 Submit, within 6 weeks of tender award, a commissioning plan per Section 13100 that minimizes interruption of the pumping station operation during construction and is consistent with the Schedule for Construction.
- .3 Without limiting the requirements of the General Conditions, the Schedule of Construction shall show detailed scheduling for all items of special nature.
- .4 The schedule shall take into account the completion date requirements set out in Information for Tenderers pertaining to "Liquidated Damages".
- .5 Changes in the approved Schedule of Construction shall not be made unless written permission is obtained from the Contract Administrator.

**End of Section**

**DIVISION 14**  
**CONVEYING EQUIPMENT**

**Division 14 Conveying Equipment - Index**

*14600 Hoists*

**End of Section**

## 1.0 GENERAL

### 1.1 Summary

- .1 This Section specifies the supply and installation of:
  - .1 One (1) adjustable offset davit and one (1) base as specified herein and shown on Contract drawings for personnel entry.
  - .2 One portable lifting davit and one davit base with lifting hoist for equipment removal.

### 1.2 Related Work Specified Elsewhere

- .1 Division 1 General Requirements
- .2 Division 3 Concrete
- .3 Division 5 Structural
- .4 Division 11 Equipment
- .5 Division 15 Mechanical
- .6 Division 16 Electrical

### 1.3 Applicable Standards and Codes

- .1 American National Standards Institute (ANSI):
  - .1 B30.10, Hooks.
  - .2 B30.11, Monorails and Underhung Cranes.
  - .3 HST 1M, Performance Standard for Electric Chain Hoists.
  - .4 HST 2M, Performance Standard for Hand Chain Manually Operated Chain Hoists.
  - .5 3HST 4M, Performance Standard for Overhead Electric Wire Rope Hoists.
  - .6 MH27.1, Underhung Cranes and Monorail Systems.
- .2 National Electrical Manufacturer's Association (NEMA):
  - .1 MG 1, Motors and Generators.
  - .2 250, Enclosures for Electrical Equipment (1,000 volts maximum).
- .3 National Fire Protection Association (NFPA): 70, National Electrical Code (NEC):
  - .1 Article 250, Grounding.

.2 Article 610, Cranes and Hoists.

.4 Ontario Health and Safety Act

#### **1.4 Quality Assurance**

.1 The Supplier shall have a minimum of seven (7) years of recent experience in the manufacturing of portable davits.

.2 Manufacturer(s) of all hoist equipment to have designed and successfully installed equipment of similar service specified under this Section and of comparable size with minimum of five (5) installations.

.3 All submittal drawings shall be stamped by a Registered Professional Engineer in the Province of Ontario.

#### **1.5 Shipment, Protection and Storage**

.1 Ship, protect and store equipment in accordance with Sections 01600 and 11050.

#### **1.6 Submittals**

.1 Submit shop drawings, manuals, parts lists, etc. in accordance with Sections 01300 and 01730.

.2 Shop Drawings:

.1 Make, model, weight and horsepower of each equipment assembly, if applicable.

.2 Complete catalogue information, descriptive literature, materials of construction, and specifications on hoist, wheels, gears and bearing, trolley drive system, hoist motor and assemblies, hook, brakes, starting system, variable speed drive system, conductors (bus bar, festoon, cable reel), controls, remote control system, and accessories.

.3 Structural design calculations for monorail track and support system and calculations of deflection and loads on building steel certified correct by a registered Professional Engineer in the Province of Ontario.

.4 Detailed Shop Drawings of all davit cranes, including dimensions of base and recommended mounting bolt size and grade.

.5 Detailed Shop Drawings of monorail track, brackets, hangers, and their attachments to building structural steel, as applicable.

.6 Power and control wiring diagrams, including terminals and numbers.

.7 Motor nameplate data in accordance with NEMA MG 1, and include any motor modifications.

.8 Factory finish system

- .3 Suggested spare parts list and a list of special tools required for checking, testing, parts replacement, and maintenance with current price information, in accordance with Sections 01300 and 01730.
- .4 Submit installation manuals before shipping equipment.
- .5 Submit certified test results of load tests for hoists.

## 2.0 PRODUCTS

### 2.1 General Description

- .1 Refer to the Contract Drawings for further details.
- .2 All hooks to be stainless forged steel. All hooks to have a safety latch.
- .3 Portable Davit Cranes to be portable as a whole, or in easily dismantled sections, light enough such that one person can remove the davit by hand and transport it to another socket (less than 20 kg total mass).
- .4 Davit boom shall rotate 360° around base.
- .5 All lifting systems shall be capable of overcoming the initial dislodging force, overcoming friction including pump and lifting chain weight (the sum of all of these weights is referred to as the minimum weight).
- .6 Portable lifting davit shall be manufactured from materials that are compatible and shall not corrode, and will operate safely, in all weather conditions.

### 2.2 Lifting Davits

- .1 Supply one (1) lightweight, portable lifting davits (with chain hoist) as specified herein.
- .2 A total of one (1) davit sockets are to be provided and installed, as specified herein and shown on the Contract Drawings, to enable portable davit to perform the following functions:
  - .1 Raw Sewage Pump removal
- .3 Lifting davits as specified herein and shown on Contract Drawings:
  - .1 Lightweight, corrosion-resistant, aluminum alloy construction, with powder coated finish, 5 radius adjustments, Grade L9 fasteners
  - .2 Minimum 1000 kg (2,200 lb.) lifting capacity (to be verified during shop drawing review)
  - .3 10 m available lifting height (field verify)
  - .4 Total assembled weight less than 19.6 kg (43 lb)

- .5 Lifting davit shall indicate the capacity
- .6 Supply sufficient 316SS Hilti Anchors with appropriate epoxy
- .7 Include one (1) aluminum socket extender, 42" height and assembled wt. 34 lbs. for pump removal.
- .4 Acceptable Manufacturer:
  - .1 Easily Moved Equipment Inc.
  - .2 Approved equal.

### 2.3 Chain Hoists

- .1 The lifting davit at the pump hatch shall be supplied with one (1) R&M manual chain hoist with chain container. Hoist capacity shall be equal to the lifting capacity of the lifting davit specified and be supplied with 10m (30 ft.) of galvanized chain and one grip eye.

### 2.4 Adjustable Offset Davit

- .1 Supply one (1) lightweight, portable adjustable offset davit as specified herein and shown on Contract Drawings with two (2) permanent davit bases for personnel entry.
  - .1 Lightweight, corrosion-resistant, all-aluminium alloy construction with fluorescent Green powder coat finish.
  - .2 Minimum 204 kg (450 lbs.) lifting capacity working load.
  - .3 Total assembled weight of less than 18 kg (39 lbs.)
  - .4 Acceptable Manufacturer:
    - .1 3M™ DBI-SALA®
    - .2 Easily Moved Equipment Inc.
    - .3 Approved Equal.
- .2 A total of two (2) bases are to be installed at the following locations:
  - .1 One (1) at the wet well access hatch. as shown on the Contract drawings.
  - .2 Bases to include locking caps and appropriate Hilti Chemical Anchors.
  - .3 Acceptable Manufacturer:
    - .1 Easily Moved Equipment Inc
    - .2 Approved equal.

## **2.5 Self-Retracting Lifeline (SRL)**

- .1 Supply one (1) Self-Retracting lifeline, with rescue retrieval, compatible with the adjustable offset davit specified and supplied with 50 ft SS wire rope.
- .2 Acceptable Manufacturers:
  - .1 3M™ DBI-SALA®
  - .2 Easily Moved Equipment Inc.
  - .3 Approved equal.

## **2.6 Accessories**

- .1 Equipment Identification Plate: 16-gauge stainless steel with 6-mm die-stamped equipment tag number securely mounted in a readily visible location.
- .2 Apply label with load carrying capacity to hoist and cranes that is in agreement with Engineer's Signed Drawings.
- .3 Lifting Lugs: Equipment weighing over 45 kg.

## **2.7 Finishes**

- .1 Prepare and prime coat in accordance with manufacturer's standard.

## **3.0 EXECUTION**

### **3.1 Installation**

- .1 Installation to be according to manufacturer's recommended practices and according to onsite installation supervisor's instructions.
- .2 Any required extension of installation time required shall be at no additional cost to the Owner.
- .3 Provide initial lubrication, and all fittings required for lubrication required as part of regular maintenance.
- .4 Provide the services of a factory trained representative to inspect, operate, test, adjust, and troubleshoot the installation.

### **3.2 Painting**

- .1 Paint to be shop applied prior to delivery to site and touched up if damaged or scratched.

### **3.3 Field Tests**

- .1 Functional Tests: Conduct on each hoist system.
  - .1 Alignment: Test complete assemblies for proper alignment and connection, and quiet operation.
- .2 Performance Test:
  - .1 Conduct load tests on each hoist in compliance with OSHA, Regulations for Industrial Establishment, ANSI B30.11, and ANSI MH27.1.
  - .2 Provide weights and suitable means for connection of weights to the hoist hook.

### **3.4 Warranty**

- .1 The Manufacturer shall provide a 10 (ten) year parts and labour warranty on all davit and socket components against defects in workmanship and materials from the date of start-up. All components shall be fully tested prior to shipping. Warranty on all hoists and accessories shall be two (2) years from start-up.

### **3.5 Services of the Manufacturer**

- .1 Manufacturer's representative shall provide onsite services as required to provide Manufacturer's Report and assist the Contractor in the equipment delivery, storage, installation, performance of all testing requirements, and start-up of the furnished equipment.
- .2 Manufacturer's representative shall provide onsite services to support the Owner for training and other services as specified in Section 01650.
- .3 A factory trained manufacturer's representative with a minimum of ten (10) years direct experience with the specified system shall conduct necessary training with operations staff to ensure a thorough understanding of the davit system. Load testing of the contractor socket installations shall be conducted at this time. Load test shall be static 125% of the rated load of the davit unit.
- .4 Inspection to include checking for:
  - .1 Cracks and other damaged or 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.
- .5 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.

END OF SECTION

**DIVISION 15  
MECHANICAL**

## **Division 15 Mechanical - Index**

- 15000 General*
- 15050 Mechanical General Provisions*
- 15051 Pipe Welding*
- 15053 Motors, Drives, and Guards*
- 15060 Process Piping Systems*
- 15070 Piping Supports*
- 15100 Process Valves*
- 15190 Mechanical Identification Systems*
- 15400 Plumbing and Drainage*

**End of Section**

## 15000 General

### 1.0 General

#### 1.1 Order of Priority

- .1 The instructions given in this Section are to be given precedence with regard to Contract interpretation over the following sections within this Division.
- .2 Notwithstanding clause 1.1.1 above, instructions given Division 1 – General Requirements are to be given precedence with regard to Contract interpretation over those in this Division.

#### 1.2 Intent of Specifications

- .1 It is the intent of these Specifications and the Contract Drawings to detail and provide for a completely functional and operating system.
- .2 Any items required for operation or installation of any component, the co-operation of any multiple components, and the system as a whole, even if not explicitly detailed in the aforementioned documents, shall be considered to form part of the Work.
- .3 The Contractor shall be responsible for providing items detailed in clause 1.2.2 of this Section at no additional cost to the Owner except as allowed in the sole discretion of the Engineer.

#### 1.3 Engineer and Contract Administrator

- .1 In this Division, Engineer and Contract Administrator are deemed to have the same meaning.
- .2 The Engineer is as defined in the General Conditions section of this Contract.

#### 1.4 Submission of Alternate Proposals for Products or Material

- .1 If the Contractor requests use of an alternate product or material then he/she is solely responsible for undertaking the necessary effort to demonstrate to the Contract Administrator that it meets or exceeds the requirements of the specification and to demonstrate a cost savings to the contract in accordance with Section 01035.
- .2 If an alternative product or material is accepted for use then the Contractor is responsible at his/her cost to ensure that any impacts resulting from its use are mitigated to the satisfaction of the Contract Administrator.
- .3 The Contract Administrator reserves the right to reject for any reason the use of an alternate product or material.

#### 1.5 References to Standards

- .1 If references to standards appear in this Division, it is the intention of these Specifications to refer to the standard that was in effect at the time of the tender close for this Contract regardless of the date or version of the standard stated in the Division.

#### 1.6 Equipment

- .1 All major equipment suppliers shall be onsite during commissioning.

**End of Section**

## 15050 Mechanical General Provisions

### 1.0 General

#### 1.1 General Requirements

- .1 The specifications of Section 15050 apply to and govern all work of Division 15.
- .2 Section 15000 takes precedence over this section.

#### 1.2 Scope of Specifications

- .1 The listing hereinafter of any article, material, operation or method requires that this Division is to provide each item listed of the quality and subject to the qualifications noted, and this Division is to perform each operation prescribed according to the condition stated, providing therefore, all necessary labour, equipment and incidentals.

#### 1.3 Scope of Work

- .1 Related Work Specified Elsewhere
  - .1 Division 11 Equipment
  - .2 Division 16 Electrical
- .2 Work Included
  - .1 The Contractor is to include the supply of all labour, tools, equipment and materials for the installing, testing and putting into proper operation the complete system as herein specified, as shown on the drawings, or as is reasonably inferable from either or both.
- .3 Equipment items that are supplied as packaged units under this division are to include all internal wiring, relays, contactors, switches, transformers, motor starters, controls and ancillaries as required for the intended operation, and to be complete with all necessary terminals suitable for connection to power source, and external devices at a single location.

#### 1.4 Intent of Specifications and Drawings

- .1 Any specified item or work omitted from one and which is mentioned or reasonably implied in the other is to be considered as properly and sufficiently specified and must be provided by this Division.
- .2 Should any discrepancy or conflict appear between these specifications and the drawings which leave this Division in doubt as to the true meaning and intent of the drawings and specifications, a ruling is to be obtained from the Consultant before submitting the tender. If clarification is not sought prior to the closing of tender, the Consultant's decisions are final, conclusive and binding on this Division.

#### 1.5 Regulation and Permits

- .1 All work to be carried out in accordance with the latest editions of all relevant authorities, codes, or regulations including but not limited to Ontario Building Code, including Part 7, Plumbing; Canadian Regulations for the Construction and Inspection of Pressure Vessels; Ontario Fire Code, Ministry of Labour Guidelines, occupational Health and Safety Act, Ontario Electrical Safety Code, Gas Utilization Code, Canadian Heating, Ventilating and Air Conditioning Code, NFPA, Canadian Standards Association, ASHRAE Standards and TSSA.

- .2 All authorized code inspections required by above mentioned laws, rules and regulations, inclusive of any fees, obtaining of permits, and issuance of notices are to be arranged and paid for by this Division.
- .3 Furnish all necessary certificates as evidence that work installed complied with aforementioned laws and regulations of all governing authorities, prior to acceptance of the work and before the final certificate of payment is issued.
- .4 Any deviations from the plans or specifications requested by an official representing one or any of the authorities having jurisdiction over that portion of the work must be brought to the attention of the Consultant prior to proceeding with the change. Any additional costs incurred for extra work performed without instruction from the Consultant will not be considered.

#### **1.6 Examination of Site and Documents**

- .1 The Contractor and related sub-trades, before tendering, are to examine the site and all drawings and specifications of other trades and familiarize himself with local conditions, building construction and finishes affecting the work under this section. No allowances are to be made for any extra expense incurred by him through his failure to do so.

#### **1.7 Contract Drawings**

- .1 The Contract drawings show the minimum standard acceptable regardless of any lesser standards set by any codes or regulations having jurisdiction.
- .2 The entire contract drawings and package are to be examined to ensure that the work of the Contractor may be satisfactorily completed.

#### **1.8 Storage of Materials**

- .1 Proper facilities for storage and protection of material and equipment are to be provided at the job site by this Division.
- .2 All pipes to be used on the job to be carefully stacked off the floor with ends capped or suitably plugged to prevent the entry of dirt, etc. until such times as when the piping is being installed. Similarly all openings in pressure vessels, tanks, etc., to be kept closed until ready for use. Any piping not suitably protected to be removed from the site and replaced with new.
- .3 Equipment located on site, must also be suitably protected to prevent damage from abuse or misuse. Equipment and/or materials damaged after delivery to site is to be replaced or repaired to the satisfaction of the Engineer.
- .4 Make known, any hazardous or flammable materials to be used and method of application before using. This Division shall be responsible for proper storage and all necessary safety requirements in the storage and use of all hazardous and flammable materials used in the execution of their work.

#### **1.9 Co-operation of Trades**

- .1 The Contractor is to co-operate with all other trades on the job, so that all equipment can be satisfactorily installed, and so that no delay is caused to any other trade. Any reworking of installed equipment, piping or ducting to accommodate the installation of other trades work shall be performed at no extra cost.

#### **1.10 Warranty**

- .1 The Contractor is to warranty products and execution of work under this Division against defects of material and workmanship for one full year after date of Substantial Performance.

- .2 Repair defects that are discovered or develop during this period and make good any resulting damage to equipment or building. Repairs are to be carried out at no cost to Owner.
- .3 Provide extended warranties where indicated in other sections of this Division. Extended warranties are to commence on termination of the standard one year warranty and to be an extension of these same provisions.

### **1.11 Local Utilities**

- .1 The Contractor before tendering to contact all utilities is to determine the local procedures and policies concerning services, and portions of that service which would be supplied or available through the utilities and incur any cost. The Contractor is to ensure no delays in construction or service connections.

### **1.12 Existing Services**

- .1 Where work involves breaking into or connecting existing services, carry out work at times directed by governing authorities, with minimum of disturbance to the premises and its operation.
- .2 Before commencing work, establish location and extent of service lines in area of work and notify Consultant of finding.
- .3 Where unknown services are encountered, immediately advise Engineer and confirm findings in writing.
- .4 Remove abandoned service lines. Cap or otherwise seal lines at cut-off points, in manner approved by authorities having jurisdiction over service.
- .5 Record locations of maintained, re-routed and abandoned service lines. The sub-contractors concerned shall provide this Division with all necessary dimensions required to accurately locate those services.
- .6 Where the location of any of these utilities has been shown on the plans, such information is not guaranteed. It is the responsibility of this Division to verify locations, elevations, etc., immediately after they move on site. If for any reason the information obtained necessitates changes in procedures or design, they must advise the Consultant at once. If this verification of existing conditions is not done at the outset and any problems arise, the responsibility for same is entirely this Division's.

## **2.0 PRODUCTS**

### **2.1 Materials**

- .1 Any equipment installed without the Engineer's written approval, is to be removed and the correct equipment installed at this Division's expense. No consideration is to be allowed for claims of delay of schedule in this case.
- .2 In the event the approved alternate equipment is not available for any reason, the specified equipment is to be installed, any and all costs incurred is the responsibility of this Division.
- .3 The Engineer reserves the right to accept or reject an alternative without explanation.

### **2.2 Access Doors (not applicable)**

- .1 The Contractor to supply and install access doors of adequate size and with appropriate clearances, wherever any equipment, cleanouts, valves, dampers, fire dampers, etc., which require service, maintenance or removal and are built in or concealed behind walls, or ceiling. Coloured thumb tacks are to be used in acoustic tile ceilings.

- .2 Access doors to be 14 U.S.S. gauge steel with concealed hinges, anchor straps, screwdriver operated lock, rounded safety corners and dust tight doors that open 180 deg. Doors are to be adequately sized to suit equipment which is to be accessed, but in no case smaller than 8" x 8" (200mm x 200mm)
- .3 In acoustic tile ceiling, where access cannot be achieved through tile, install access doors to suit tile. Markers are to be approved colour coded markers to indicate type of valve or equipment concealed.
- .4 Where access doors are to be installed in a fire rated assembly, the access door must have a fire rating equal to or greater than the assembly fire rating. Fire rated access doors to be ULC rated and in accordance with NFPA-80.
- .5 Acceptable manufacturers: Acudor, Le Hage, Mi-Fab.

### **2.3 Supports**

- .1 The Contractor shall furnish and install all special structural work required for the installation of mechanical equipment and motors etc. All details to meet the approval of the consultant and drawings are to be submitted for all major steel supports.
- .2 Where on drawings or specifications special isolation bases are noted, these shall be the responsibility of this Division.
- .3 All equipment shall be properly aligned on bases before being bolted down.
- .4 All floor mounted equipment to be set at least 4" (100mm) above the floor on concrete bases, and anchored securely with anchor bolts unless indicated otherwise. Installation of bases and all associated work to be by Division 3, identified accurately by this Division as to location and dimensions.

### **2.4 Electrical Motors and Wiring**

- .1 Refer to drawing schedules for voltage requirements of all motors.
- .2 All starters and line voltage wiring shall be supplied by Division 16 unless specified otherwise.
- .3 All motors required for this Contract shall be supplied by this Division.
- .4 All fractional horsepower motors to have internal overload protection.
- .5 Supply electrical disconnect switches where indicated in schedules.
- .6 Provide motors of adequate size and type for intended service. Unless stated otherwise, all motors 1 HP (746W) and above to be high efficiency conforming to A.S.H.R.A.E. Standard 90.1 Table 5.1 latest supplement. Unless stated otherwise, use ambient temperature of 104 Degrees F (40 deg.C).

### **2.5 Special Tools and Spare Parts**

- .1 Furnish spare parts as follows:
  - .1 Where spare parts are identified in each Division section for specific equipment, those quantities and type shall be provided.
- .2 Identify spare parts containers as to contents and replacement parts number.
- .3 Provide one (1) set of special tools where required to service equipment as recommended by manufacturers.
- .4 Provide list of spare parts provided in operating and maintenance instructions.

### **3.0 EXECUTION**

#### **3.1 Installation**

- .1 Each piece of equipment or material to be checked against the specification and reviewed shop drawing before installation, all clearances and installation instructions are to be strictly adhered to. Failure to comply with the instructions shall result in removal and proper reinstallation of the equipment at no cost to the owner.
- .2 Where mechanical equipment is installed in a fire rated assembly provide fire dampers, drywall enclosure or other as required to maintain the assembly fire rating to the approval of this Division. Include all costs.

#### **3.2 Sleeves, Holes and Patching**

- .1 All cutting and patching to be as specified under the General Conditions and Supplementary Conditions bearing in mind that the integrity of the fire separations are to be maintained at all times.
- .2 All holes, pipes chases, etc., through walls and floors that are not fire separation are to be large enough to accommodate the thickness of insulation specified.
- .3 All cutting and patching, sleeves, grouting, painting and drywall required by this Division is to be performed by fully qualified craftsmen of that respective trade. All cutting and patching required by this Division to be provided by this Division, unless indicated otherwise.
- .4 All holes, pipe chases etc., through walls and floors that are fire separations are to be ½" (13mm) larger in diameter than the pipe and the void will be properly fire stopped as specified.
- .5 Holes through masonry walls are to be sleeved with schedule 40 steel pipes, all other holes to be sleeved with light gauge metal sleeves, unless indicated otherwise.
- .6 Holes through exterior walls and roof are to be properly flashed and made weatherproof. Refer to Architectural drawings for details.
- .7 Sleeves for un-insulated pipes are to be sized to allow ½" (13mm) clearance between the pipe and the sleeve. The space between the pipe and sleeve to be sealed with Rockwool insulation to avoid smoke, sound and dust transmission and fire stopped.
- .8 Pipes are not to be in direct contact with plaster, concrete or any other finishing material.
- .9 Sleeves for all piping penetrating mechanical room floor to extend 2" (50mm) above the finished floor and sealed at the floor.
- .10 Sleeves in potentially wet floor areas to extend at least 1" (25mm) above the finished floor.
- .11 Ensure no contact between copper tube or pipe and ferrous sleeve.
- .12 This Division to provide detailed dimensioned drawings prior to pouring floors, erecting masonry, or installing roof deck. Drawings to indicate size and location of all openings to ensure correct bridging installed as indicated under Division 5.
- .13 This Division is responsible to install sleeves for piping and ducts and frames for openings for grilles, louvers etc., as the construction progresses. If these sleeves and frames are not installed by this Division during construction the cost of cutting openings, chases and installing the sleeves and frames is to be at this Division's expense by the respective trade involved.
- .14 Provide sleeves for all ducting penetrating floors and masonry or concrete walls.
- .15 Ducts penetrating fire separations to have any voids between the duct sleeve and fire separation to be properly fire stopped as specified. Ducts penetrating non fire separations to

have any voids between the duct sleeve and separation filled with Rockwool insulation to avoid smoke, sound and dust transmission.

- .16 Supply and set all necessary sleeves for this work prior to pouring of concrete.
- .17 Approval of the location, size and proposed method of cutting through structural components must be received before proceeding.

### **3.3 Workmanship**

- .1 Employ an experienced, responsible tradesperson to supervise the work and retain this supervisor on the job throughout the construction period until completion of work, and all mechanical systems are fully operational and have been commissioned and demonstrated to the owners unless otherwise approved or directed by the Consultant.
- .2 Employ only skilled licensed pipe fitters, etc. for execution of work. Workmanship to be first class not only as regards durability, efficiency and safety, but also as regards to neatness of detail.
- .3 Set equipment accurately, plumb and level and align hanger rods and steel supporting structures.
- .4 Products and installations in the opinion of the Consultant found to be defective; not in accordance with specifications; damaged or defaced; or of poor workmanship to be rejected.
- .5 Rejected work is to be repaired or replaced at no cost to the owner.

### **3.4 Use of Fans**

- .1 While construction is still in progress the use of or running of system ventilation fans for the purpose of ventilation, drying of plaster, etc., will not be permitted.

### **3.5 Belt Drives, Sheaves, and Guards**

- .1 Provide all belt driven equipment with V belt drive, designed for at least 150% of motor nameplate horsepower rating and in accordance with manufacturer's recommendations for type of service intended. Belt drives to be at least 95% efficient. Balance and properly align all drives. Provide matched sets of belts for multiple belt assemblies. Select belts to suit starting torque of driver. Use single belt drives only for motors 2hp (1492 watt) and smaller.
- .2 Provide motor sheaves for one and two belt drives of variable pitch type, with Dodge key adjustments. Supply one set of fixed drive sheaves for drives with two or more belts. Install fixed motor sheaves to obtain the originally specified rpm. After initial test and preliminary adjustment, supply and install a second set of fixed sheaves if necessary, to provide the design flow quantities as established on the job. Obtain correct total flow rate for fans through speed changes and not by throttling.
- .3 All equipment that is belt driven must be a complete installation including a sturdy, firmly supported, removable belt guard to give full protection and safety from any rotating part.

### **3.6 Piping**

- .1 All Piping for this Division is to be run concealed where possible and grouped so that valves, etc., are accessible through as few access panels or doors as possible, while still maintaining adequate working space.
- .2 Piping that does not present a neat workmanlike appearance, in the opinion of the Consultant, is to be reworked according to his instructions without extra cost to the owner. Arrange piping within pipe chases that have been designed for access of personnel to ensure that access is not impeded.

- .3 In specifically designated unfinished areas such as mechanical rooms or existing areas, run pipes neatly parallel or in banks and group valves. Piping may run exposed in these designated areas. The crossing over of pipes must be kept to a minimum.
- .4 The piping shown on the drawings is located diagrammatically in the space in which it is intended to run. Co-operate and co-ordinate with the work of other Divisions, also installing pipes, conduits, ducts, etc., within the same area. No extras are to be paid for any relocation of piping to suit the work of the other Divisions.
- .5 Separations by approved dielectric unions are to be applied to all ferrous and nonferrous domestic water piping. Separation of ferrous and non-ferrous piping on closed loop systems to be accomplished with the use of brass or bronze fittings and/or valves. All connecting or touching metals that could give rise to electrolytic action are to be separated by insulation.
- .6 All piping is to be installed with adequate change of direction, expansion joints and anchors, so that the piping and equipment will in no way be strained or distorted by expansion and contraction.
- .7 If on the job circumstances require additional change of direction and expansion loops, furnish and install same at no extra cost.
- .8 All take offs from the mains to be made using swing joints wherever possible.
- .9 Hydronic branches serving down the feed risers are to be taken from lower sides or bottom of mains and grade down slightly to risers. Branches which serve units above the mains are to be taken from the top or sides of mains.
- .10 Anchors are to be provided where necessary to protect equipment and to generally be made from ½" (13mm) M.S. plate with structural steel angle and channel sections.
- .11 Suitable anchors and guides are to be provided where shown or where necessary for all vibration devices.
- .12 Expansion loops are to be located midway between anchors except where shown otherwise. All expansion loops to be cold sprung 50% in accordance with the latest edition of the ASHRAE Guide.
- .13 Install all water piping so that lines can be drained. Provide drip tee with ¾" (19mm) ball valve with cap and chain.
- .14 All exposed plumbing piping in finished area to be chrome plated unless indicated otherwise.

### **3.7 Valve Tags**

- .1 All valves installed under this Division to have securely affixed to them an approved valve tag bearing an engraved number which shall be used to identify the valve on an indexed valve list prepared and mounted in a glazed frame in the mechanical room.
- .2 Beside each number on the list of valves to be listed, identify the function normal position, and location of valve so tagged.

### **3.8 Painting (not applicable)**

- .1 All field priming and finishing to be performed by Division 9 if included.
- .2 Provide field surface preparations, priming and finishing of the work of this Division including exposed bare (or insulated) pipe work, fittings, ductwork, miscellaneous metals, supports, and equipment, in accordance with Division 9 if included.

### **3.9 Placing in Operation**

- .1 Prior to acceptance and on completion of work make a complete operational test of systems and work carried out under Division 15.
- .2 At all fixtures, adjustments for correct water flow to be made, this is to include hot and cold water systems and flush valves.
- .3 At all drains, covers and gratings are to be removed and cleaned, traps cleaned out and drains thoroughly flushed.
- .4 All strainers are to be cleaned out after two weeks normal operation.
- .5 All filters in fan cabinets are to be removed, thoroughly cleaned and stored for future use, install new filters in units. Bird and insect screens on all louvers to be cleaned. All coils to be combed out where necessary and vacuumed out.
- .6 Balancing will be carried out and systems set to designed values, and a report of final actual performance of all equipment and balancing for final space conditions on cooling and heating to be carried out when relative climatic conditions exist.

### **3.10 Clean-Up**

- .1 Avoid accumulation of scrap and debris resulting from the operations of this Division and at all times help maintain the working site in a neat and clean condition. On completion of the contract, remove all scrap and debris resulting from the work of this Division and clean all equipment installed by this Division.

### **3.11 Start-Up Service**

- .1 Provide services of a qualified technician responsible for assisting the Owner's staff in becoming familiar with operating of systems, co-ordinating work of control manufacturer, acting on any complaints from the Owners, or Consultants regarding operation of any of the systems, installed under this Division.
- .2 Provide start-up of major pieces of mechanical equipment or systems, by representative of equipment manufacturer or person qualified and recognized by the equipment manufacturer.
- .3 Submit start-up reports on all mechanical equipment and systems verifying correct installation and operating parameters in all modes of operation. Include service reports in operating and maintenance manuals.
- .4 Notify Consultant prior to start-up on any piece of mechanical equipment or system. Demonstrate operation of all or any mechanical system or equipment as directed by the Consultant in his presence.

### **3.12 Testing**

- .1 Notification of Tests: Consultant must be given at least 48 hours' notice of date and time of which any and all tests are to be carried out. Under no circumstances must a test be assumed conclusive unless it has been witnessed by the Consultant or his designated representative.
- .2 Test all piping system for leaks, providing gauges, materials and labour as required. Equipment furnished as part of the permanent installation shall not be used for testing purposes. Before testing, remove all equipment which is not designed to withstand the test pressures. All piping is to be tested before covering is applied.
- .3 Before final payment, test the operation of each system and all equipment installed, make all necessary adjustments and replacements, and demonstrate to the satisfaction of the Consultant that all equipment is operating as intended and without undue noise and vibration.

**End of Section**

## 15051 Pipe Welding

### 1.0 GENERAL

#### 1.1 Related Requirements

- .1 Section 15050 – Mechanical General Provisions.

#### 1.2 Reference standards

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - .1 ANSI/ASME B31.1-2018, Power Piping.
  - .2 ANSI/ASME B31.9-2017, Building Services Piping.
  - .3 ANSI/ASME Boiler and Pressure Vessel Code-2019:
    - .1 BVPC 2019 Section I: Rules for Construction of Power Boilers
    - .2 BPVC 2019 Section V: Non-destructive Examination.
    - .3 BPVC 2019 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C206-17, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
  - .1 AWS B2.1/B2.1M-2014, Specification for Welding Procedure and Performance Qualification
  - .2 AWS C1.1M/C1.1:2019, Recommended Practices for Resistance Welding.
- .4 Canadian General Standards Board (CGSB)
  - .1 CGSB 48.2-1992, Spot Radiography of Welded Butt Joints in Ferrous Materials
  - .2 CGSB 48.9712-2014, Non-Destructive Testing - Qualification and Certification of NDT Personnel.
- .5 Canadian Standards Association (CSA International)
  - .1 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
  - .2 CSA W48-18, Filler Metals and Allied Materials for Metal Arc Welding.
  - .3 CSA W59-18, Welded Steel Construction (Metal Arc Welding).
  - .4 CSA-W117.2-12 (R2017), Safety in Welding, Cutting and Allied Processes.

- .5 CSA W178.1-18, Certification of Welding Inspection Organizations.
- .6 CSA W178.2-18, Certification of Welding Inspectors.

### 1.3 Quality assurance

- .1 Qualifications:
  - .1 Welders
    - .1 Welding qualifications in accordance with CSA B51 and ASME B31.1 Section 127.5, if applicable.
    - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
    - .3 Submit welder's qualifications to Departmental Representative.
    - .4 Each welder to possess identification symbol issued by authority having jurisdiction.
  - .2 Inspectors:
    - .1 Inspectors qualified to CSA W178.2 and CGSB 48.9712 with minimum Level II Certification for specific type of testing with a pressure vessel and piping endorsement.
  - .3 Certifications:
    - .1 Registration of welding procedures in accordance with CSA B51.
    - .2 Copy of welding procedures available for inspection.
    - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.
  - .4 Program:
    - .1 Maintain a Quality Assurance Program for defect prevention and in-service reliability conforming to CSA B51 Part 1.
    - .2 Maintain on site: Quality Assurance Program and Quality Control Manual, welder certifications, weld procedures and all NDE test results.
  - .5 Visual test inspection of welds shall take place prior to, during, and after completion of all welds.
  - .6 Pressure welders shall be used for contained pressure in excess of 100 kPa.
  - .7 Material log and material test reports (MTR). MTR is a report confirming the materials conformance to a specific material grade or designation. MTR's are supplied by the mill producing the material and must include, as a minimum, the following information;
    - .1 Place of manufacturer.
    - .2 Identification of the standard the material has been produced to, i.e. ASTM, NACE.
    - .3 Chemical composition.
    - .4 Physical properties.
    - .5 Mechanical properties.
    - .6 Certification, i.e. QA managers signature.
    - .7 Heat treatment.
  - .8 Welder log:

- .1 Self-formatted and maintained record of the welding procedures for which each individual welder has been qualified to perform. Welders logs must also contain the dates of the qualification, expiration dates and the unique identifying symbol assigned to each welder to identify his work when required.

#### 1.4 Closeout submittals

- .1 Submit in accordance with Section 15050 – Mechanical General provisions. Include:
  - .1 Weld maps to be included in redline as-built drawings
  - .2 Results of weld quality tests; Non-Destructive Testing (NDT) methods as appropriate to suit the welding application:
    - .1 Radiographic.
    - .2 Ultrasonic.
    - .3 Magnetic particle.
    - .4 Liquid penetrant.
  - .3 Submit results of NDT tests, together with copy of welder's licence and description of procedures used, to inspector of insurance company under contract to City of London.
  - .4 Welder log.
  - .5 Welding Procedure Specification (WPS).
  - .6 Procedure Qualification Record (PQR).
  - .7 Material log and material test reports (MTR).

## 2.0 PRODUCTS

### 2.1 General

- .1 Install and weld piping and fittings in accordance with required ASME/ANSI Code of Construction for each system.

### 2.2 Electrodes

- .1 Electrodes: in accordance with CSA W48 Series.
- .2 All filler materials shall be fully identified by the ASME Specification number and the AWS classification number.
- .3 Filler metal storage and handling procedures shall be required to maintain the material in a clean and dry condition up to the time of use. A materials log shall be kept for all electrodes. Heat number and MTR (material test report or mill test report).
- .4 Low hydrogen electrodes shall be handled and stored in accordance with the manufacturer's recommendations to avoid pickup and to retain the low hydrogen characteristics of the electrode. A method of keeping electrodes warm and moisture free shall be available with each welder.
- .5 The methods to be used for handling and storing electrodes shall be covered in the welding

procedure or Contractor's Quality Control Manual.

### **2.3 Base materials**

- .1 Use base materials consisting of carbon steels listed in Table 126.1 or ANSI B31.1 which have ASME equivalents listed in P-1 group No. 1, Table QW422 of ASME Section IX. Either the ASTM materials listed or their ASME equivalents shall be acceptable.
- .2 All base materials shall be identified by specification number and grade, class, or type when recorded on a welding procedure specification's procedure qualification record, or the record of welder qualification test.
- .3 Ring or saddle reinforcements, doublers, lugs, etc., shall be made from material having the same general chemical composition as the pipe headers, or nozzles to which they will be joined unless otherwise specified or unless prior written approval is obtained from the Access doors to be 14 U.S.S. gauge steel with concealed hinges, anchor straps, screwdriver operated lock, rounded safety corners and dust tight doors that open 180 deg. Doors are to be adequately sized to suit equipment which is to be accessed, but in no case smaller than 8" x 8" (200mm x 200mm)

## **3.0 EXECUTION**

### **3.1 Performance of work**

- .1 Perform work in accordance with Section 15050 – Mechanical General provisions. Supplemented as noted herein.

### **3.2 Quality of work**

- .1 Welding: in accordance with ANSI/ASME B31.1, B31.9, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B2.1, AWS C1.1, and special procedures specified elsewhere in Division 23 and in accordance with applicable requirements of federal and provincial authorities having jurisdiction.
- .2 The Departmental Representative reserves the right to request a welder be removed from a project due to poor performance including weld failure rate deemed to be excessive at the discretion of the Departmental Representative.

### **3.3 Fume minimization and extraction**

- .1 Utilize welding materials and procedures that minimize fumes and smoke generation.
- .2 Use fume extractors when welding. Follow manufacturer's recommendations for selecting the appropriate extractor and maintaining filter cleanliness.

### **3.4 Installation requirements**

- .1 Identify each weld with welder's identification symbol.
- .2 Maintain weld maps and logs identifying the location of all welds performed on the piping system together with the identification of the welder performing the weld.

- .3 Backing rings are not permitted.
- .4 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.
- .5 Weld Procedures:
  - .1 Follow the welding procedure for the type of piping system to be welded and the associated piping code standard that would apply (either ASME B31.1 or ASME B31.9 as indicated in associated piping system specification)
  - .2 All welders shall be qualified for each procedure to be welded (PQR).
- .6 Structural welding shall conform to CSA Standard W59.

### 3.5 Joint fit-up

- .1 Valves welded into the system shall be open as the welding is carried out.
- .2 The geometry of pipe weld joints (i.e. joint preparation and root opening) shall be in accordance with the tolerance specified by the weld joint sketches and/or PQR contained in the welding procedures submitted to the Departmental representative.
- .3 Each joint should be tack welded in place and the welding inspector shall visually check all welds before implementing the welding to ensure proper fit up and clean surface to the weld. In cases where the internal misalignment exceeds 1.5mm (1/16 inch), the tack well shall be removed, and the piping shall be realigned to fit within the acceptable tolerance.

### 3.6 Inspection and tests - general requirements

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
  - .1 For visual tested (VT), RT, UT, PT and MT methods, acceptance criteria shall be as per applicable piping design code
  - .2 Arc strikes and arc burns on pressure boundaries shall not be permitted.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector and hydrostatic pressure test is complete.
- .4 All welds shall be 100% VT in accordance with the applicable acceptance criteria. VT is to be performed before any other required NDE.
- .5 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified at no additional cost to the contract.
- .6 Departmental Representative may use any method of inspection necessary to establish

quality control and assure adherence to proper welding procedures.

- .7 The method of inspection to be used may be changed by the Departmental Representative at their discretion.
- .8 The limitations as to weld imperfections shall be in accordance with the applicable section of the ASME B31.1 and ASME B31.9 piping codes.

**3.7 Specialist examinations and tests**

- .1 General
  - .1 Perform examinations and tests by specialist qualified in accordance with CSA W178.1 and CSA W178.2 and approved by Department Representative.
  - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
- .2 Weld inspections will be performed as a minimum, by the method and in the quantity identified in the following table:

**Table 1:**

Piping Design Code	Frequency of Inspection		
	Weld Setup	Radiographic Inspection	Visual
ASME B31.9 Piping	20% of all welds	0% of all welds + 100% of all welds where new piping connects to existing.	100%, and minimum of 40% of root passes.

- .3 All documentation regarding all welds shall be reviewed by quality control and quality assurance inspector prior to leak testing.
- .4 Hydrostatically test welds to requirements of ANSI/ASME B31.1. All welds will be visually inspected for leaks during the hydrostatic test period.
  - .1 If hydrostatic testing is not possible, perform radiographic tests.
  - .2 Upon failure of welds by hydrostatic test, perform additional testing as directed by Departmental Representative at no additional cost until successful results achieved.
- .5 Visual examinations: include entire circumference of weld externally and wherever possible internally.
  - .1 Failure of visual examinations:
    - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative. A total percentage of welds may

- be selected at random by Departmental Representative in accordance with the frequency of inspections per Table 1, or greater.
- .6 Radiographic tests for piping systems.
    - .1 Spot radiography to CAN/CGSB-48.2.
      - .1 Conduct radiographic tests of welds in accordance with Table 1, with welds selected by Departmental Representative.
    - .2 Radiographic film:
      - .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.
    - .3 Interpretation of radiographic films:
      - .1 By qualified radiographer.
    - .4 Failure of radiographic tests:
      - .1 Extend testing to an additional 10% of welds by welder responsible when those welds fail tests.
      - .2 The Departmental Representative reserves the right to request any welder be replaced if the number of failures is deemed excessive. The welder will not be permitted to make further welds on the project without the approval of the Departmental Representative.

### 3.8 Defects causing rejection

- .1 As described in ANSI/ASME B31.1 or B31.9 and ANSI/ASME Boiler and Pressure Vessels Code.
- .2 Rejection of welds will be based on the weld evaluation as performed by a qualified NDT technician.
- .3 In addition, chilled water systems below 1035 kPa:
  - .1 Undercutting greater than 0.8 mm adjacent to cover bead on outside of pipe.
  - .2 Undercutting greater than 0.8 mm adjacent to root bead on inside of pipe.
  - .3 Undercutting greater than 0.8 mm at combination of internal surface and external surface.
  - .4 Incomplete penetration and incomplete fusion greater than total length of 38 mm in 1500 mm length of weld depth of such defects being greater than 0.8 mm.
  - .5 Repair cracks and defects in excess of 0.8 mm in depth.
  - .6 Repair defects whose depth cannot be determined accurately on basis of visual examination or radiographic and/or particle tests.

### 3.9 Repair of welds which failed tests

- .1 Repair welds shall be made using a written repair procedure that has been reviewed and accepted by the Department Representative to starting any repair. The procedure shall state as a minimum, the following information:

- .1 Means of excavating defects from the weld area
  - .2 NDE methods used to verify complete defect removal before repair
  - .3 Welding procedures to be used for weld repair
  - .4 NDE methods used to verify satisfactory completion of the repair
- .2 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.
- .3 Claims for delays in completion of project will not be accepted for reasons of failures of welds to pass examinations.

**End of Section**

## **15053 Motors Drives and Guards for Mechanical Systems**

### **1.0 GENERAL**

#### **1.1 Related Sections**

- .1 Section 01300 - Submittal Procedures.
- .2 Section 15000 - General

#### **1.2 References**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 90.1-01, Energy Code for Buildings Except Low-Rise Residential Buildings.
  - .2 Electrical Equipment Manufacturers' Advisory Council (EEMAC)

#### **1.3 Sections Includes**

- .1 Electrical work to conform to Division 16 including the following:
  - .1 Control wiring and conduit is specified in Division 16 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 15. Refer to Division 16 for quality of materials and workmanship.
  - .2 Supplier and installer responsibility is indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.

#### **1.4 Shop Drawings**

- .1 Submit shop drawings in accordance with Section 01330 - Submittal Procedures.

#### **1.5 Closeout Submittals**

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01330 - Submittal Procedures.

#### **1.6 Waste Management and Disposal**

- .1 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Engineer.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

## 2.0 PRODUCTS

### 2.1 General

- .1 Motors to be premium (high) efficiency, in accordance with local Hydro company standards and the requirements of ASHRAE 90.1, Unless Stated otherwise in specific equipment spec.
- .2 Provide motors for mechanical equipment as specified.
  - .1 Provide ECM motors where indicated.
  - .2 Provide VFD motors where indicated.
- .3 If delivery of specified motor will delay delivery or installation of equipment, install motor approved by Engineer for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373 W, 1/2 HP : speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .4 Motors 373 W, 1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature 40°C, 3 phase, 600 V, unless otherwise specified or indicated. Motors must be premium efficiency unless stated otherwise in specific equipment spec, Class F insulation, suitable for use with VFD's.
- .5 Explosion proof motors: CSA approved for Class I, Division 1 service.

### 2.2 Temporary Motors

- .1 If delivery of specified motor will delay completion or commissioning work, install motor approved by Engineer for temporary use. Work will only be accepted when specified motor is installed.
- .2 Ensure for temporary use with machine guards meet the requirement of OHSA, especially that the guards have no free area that is large enough to provide access with fingers to moving components. Work will only be accepted when specified motor is installed.

### 2.3 Belt Drives

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW, 10 HP : standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 Correct size of sheave to be determined during commissioning.

- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .3 Motor slide rail adjustment plates to allow for centre line adjustment.

## **2.4 Drive Guards**

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
  - .3 38 mm diameter holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .5 Wire or expanded metal screen, galvanized, 19 mm mesh.
  - .6 Net free area of guard: not less than 80% of fan openings.
  - .7 Securely fasten in place.
  - .8 Removable for servicing.

## **3.0 EXECUTION**

### **3.1 Installation**

- .1 Fasten securely in place.
- .2 Make removable for servicing, easily returned into, and positively in position.

**End of Section**

## 15060 Process Piping Systems

### 1.0 GENERAL

#### 1.1 Summary

- .1 Section includes design, supply, fabrication, installation, testing, cleaning and placing into operation of process piping systems including couplings, connections, expansion pieces, ancillary systems, and fittings.
- .2 Comply with Division 1.
- .3 Conform to Section 15050.
- .4 Conform to Section 11050.
- .5 Air piping connected to/from instruments and instrument control panels and/or packaged equipment supplied under this or other Divisions is provided under this Section. Piping for instruments and instrument control panels may not all be shown on drawings. Vent piping for instruments and instrument control panels may not all be shown on Drawings. Provide piping for instruments and instrument control panels under this Section.
- .6 Note that additional provisions, beyond those listed herein, will be required to make the process piping system compliant with seismic design and Post Disaster level of service. The Constructor will be responsible for the design and supply of materials to make the piping system compliant with Post Disaster Design level of service.

#### 1.2 Products Supplied Under Other Sections

- .1 Products installed under this Section and supplied under other Sections.

#### 1.3 Co-ordination

- .1 Coordinate removal of existing process piping systems and installation of new process piping systems with Engineer to minimize interference with Plant Operation.
- .2 Prepare and make application to TSSA as required for piping systems:
  - .1 Air Piping.
  - .2 Hazardous Material Piping.
- .3 Co-ordinate work of this Section with other trades, prior to construction, to locate pipe sleeves in cast-in-place concrete.
- .4 Co-ordinate location of pipe sleeves, prior to construction of masonry building elements.

#### 1.4 Related Sections

- |    |                              |               |
|----|------------------------------|---------------|
| .1 | Underground Piping           | Section 02600 |
| .2 | Plumbing and Drainage Piping | Section 15400 |

.3 Mechanical Insulation Section 15250

## 1.5 Submittals

- .1 Submit shop drawings, manuals, parts lists, etc. in accordance with Sections 01300 and 01730.
- .2 Shop drawings
  - . 1 Piping systems transporting compressed air with service that requires TSSA registration and inspection.
  - . 2 Piping systems over 75 mm diameter.
  - . 3 Flexible connectors.
  - . 4 Wall seals.
  - . 5 Expansion couplings.
- .3 Test reports and certificates
  - . 1 Submit test reports and certificates in accordance with Section 15050.
- .4 Installation, operation and maintenance manuals
  - . 1 Include material under this Section in Manuals.
- .5 Spare parts
  - . 1 Submit list of recommended spare parts, where applicable.

## 1.6 Definitions

- .1 Yard piping: Buried piping external to structures, buildings, and tanks up to spool piece in wall.
- .2 Test pressure: hydrostatic or air pressure used to determine system compliance.
- .3 Working pressure: typical operating pressure of piping system.
- .4 Design temperature: temperature range that piping system is to be designed for.
- .5 Tunnels, galleries, buildings: Within an environment controlled enclosure where temperature is maintained above 5°C.
- .6 Exposed above ground: Outside or within an enclosure which is not environmentally controlled so that temperature is maintained above 5°C.
- .7 Underground or buried: Placed in soil and not tied to structures.
- .8 Below structures: Below concrete slabs such as tanks, channels, buildings, galleries, pipe chases, and other similar items; but not including roadways or walkway structures.
- .9 Submerged: Regularly or occasionally submerged in liquid inside tanks and/or channels and wet wells and within 3.0 m above maximum water level of open tankage. Includes pipe and

appurtenances within manholes, vaults, chambers, and similar items.

## 1.7 Quality Assurance

- .1 In accordance with Section 15050.
- .2 Welding procedure for stainless steel:
  - .1 Follow welding procedure for stainless steel in Section 15050 and Division 1.
  - .2 10% of welded joints to be 100% X-rayed to ASTM B31.3 (normal fluid service) for following stainless steel piping systems:
    - .1 Piping systems 150 mm and larger.

## 1.8 Product Delivery, Storage and Handling

- .1 Deliver, store and handle piping and accessories in accordance with Section 15050.

## 2.0 PRODUCTS

### 2.1 Materials

- .1 Supply pipes in size and class specified in Contract Documents. Where pipe size is not specified, provide pipe required by Ontario Plumbing Code (minimum 12 mm diameter).
- .2 Supply pipe material as specified. Refer to Section 15250 for insulation requirements.
- .3 Supply fittings suitable for and compatible with class and type of pipe with which they will be used.
- .4 Process piping data sheets
  - .1 Piping materials and fittings: comply with Data Sheets' included in this Section. Data Sheets are referred to on Drawings in the Line Identification Number. Line Identification Number is made up of following components:  
  
(Nominal diameter) (Service) - (Line Number) - (Pipe Material Code)  
i.e. 300 - TW - 706 - SS is equivalent to: 300 mm dia. -Treated Water - Line 706  
Stainless Steel  
Line Number: Y; YYY is the sequential line number.

### 2.2 General

- .1 Refer to Drawings for piping systems specified in this Section.
- .2 Pipe sizes shown are nominal sizes in mm. Actual pipe dimensions are in accordance with commercially available products, unless otherwise specified.
- .3 Provide new pipe materials free from defects conforming to specified reference standard.
- .4 Comply with new reference standard superseding specified standard.
- .5 Note that additional piping specification tables are provided herein that are not included in

base design contract and may be used if changes are either proposed or required, however.

- .6 Locating Buried Pipe: The location of plastic pipelines should be accurately recorded at the time of installation. A copper or galvanized wire shall be spiralled around, taped to or laid alongside or just above the pipe during installation to permit the use of a locating device. Termination box to be installed where accessible next to chambers to locate pipes.

**TABLE 15060-1:**

ABBR	SERVICE	PIPE MAT.	DATA SHEET NO.	PRIMARY JOINT	WORKING PRESS. kPa	TEST PRESS. kPa	TEST MEDIA	TEST DURATION (hours)	DESIGN TEMP. °C	ALLOWABLE LEAKAGE	REMARKS
RWW	Raw Sewage Discharge	SS	SS1/SS2	W/FL/VIC	234	1050	Water	4	0-40	0	Plant
RWW	Raw Sewage	PVC	PVC2	BS	234	1050	Water	4	0-40	0	Buried
RWW	Raw Sewage - Temporary Pipe	PVC	PVC3	BS	234	1050	Water	4	0-40	0	Plant/Outside
RWW	Raw Sewage – emergency truck loading	SS	SS1	W/FL	234	1050	Water	4	0-40	0	Plant
DRN	Drain	PVC	PVC3	SW/FL	Gravity	Leakage	Water	4	0-40	0	Plant/Buried
VT	Vent	SS	SS1	W/FL	Gravity	Leakage	Water	4	0-40	0	Plant/Outside

Note:

1. Refer to following page for legend.

**Legend for Table 15060-1: Primary Joints.**

<b>ABBREVIATION</b>	<b>DESCRIPTION</b>
BELL	Bell
BF	Butt Fused
BS	Bell and Spigot
BV	Beveled End
BW	Butt Welded
C	Coupling
Comp	Compression
FL	Flanged
GRV	Grooved
LAP	Lap
LUG	Lug
MJ	Mechanical Joint
PSW	Plastic Socket Female
PPL	Plastic Plain
PL	Plain End, Socket Male
S	Soldered
SCR	Screwed
SO	Slip On
SPIG	Spigot
SW	Socketweld Female
TAP	Tap
TC	ChemFlare - Flared Teflon PFA tubing
THDM	Threaded Male
THDF	Threaded Female
TJ	Tyton Joint
U	Union
VIC	Victaulic
W	Welded
WF	Wafer

### 2.3 Polyvinyl Chloride (PVC) (Buried): Data Sheet No. PVC2

Data Sheet No. **PVC2**

ITEM	SIZES (mm)	GENERAL DESCRIPTION
Pipe	100 - 600	Polyvinyl Chloride (PVC) pipe 100 mm diameter to 600 mm diameter shall conform to AWWA C905 Class 165, DR25 (minimum) as determined by the Design Engineer, to be certified by the Canadian Standards Association to CSA Standard B137.2 and have Cast Iron O.D. dimensions. Forcemain installations should be white in colour.
Fittings	100 - 600	Fabricated fittings to CSA B137.3 or ductile iron conforming to C153 minimum Class of 350. All fittings to be in accordance with the Municipality of Southwest Middlesex Standards.
Joints	100 - 600	Integral bell and spigot ends with stiffened wall section and formed groove for rubber gasket.
Installation	All	.1 Lay and join pipe to CSA B182.11 and per manufacturer's instructions. .2 Install pipe with bell ends facing upgrade. .3 Install gaskets as recommended by manufacturer. .4 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned. .5 Align pipes carefully before joining. .6 Maintain pipe joints free from mud, silt, gravel and other foreign material. .7 Avoid displacing gasket or contaminating with dirt or other foreign material. Remove disturbed or dirty gaskets; clean, lubricate and replace before joining is attempted. .8 Complete each joint before laying next length of pipe. .9 Minimize joint deflection to manufacturer's recommendations. .10 Apply pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.

## 2.4 Polyvinyl Chloride (PVC): Data Sheet No. PVC3

### Data Sheet No. PVC3

ITEM	SIZES (mm)	GENERAL DESCRIPTION
Pipe	≤ 300	Schedule 80 rigid PVC Type 1, Grade 1, Class 12454-B conforming to ANSI/ASTM D1785 and CSA B137.3. Cut pipe in accordance with pipe manufacturer's instructions
Fittings	12 - 300	Schedule 80 PVC solvent weld socket type Class 12454-B, PVC Type 1 conforming to ANSI/ASTM D-2467
Unions	12 - 65	Schedule 80 PVC conforming to ANSI/ASTM D2467, Class 12454-B, PVC Type 1 with Buna-N O-Ring seal. [For CLS services use Viton or EPDM O-rings.]
Joints	≤ 300	Solvent weld to ANSI/ASTM D2467 and ANSI/ASTM D2564. Solvent cement compatible with chlorinated water at 4,000 mg/L at 15°C. Solvent weld supplied by pipe manufacturer suitable for type of pipe.
Flanges	80 - 300	Schedule 80 PVC Type 1, Grade 1, ANSI B16.5 Class 150 Flange conforming to ANSI/ASTM D2467, Class 12454-B
Bolts	All	ASTM A-307 Grade B zinc chromate plated carbon steel heavy hexagonal head bolts, epoxy coated
Nuts	All	ASTM A-563 Grade A zinc chromate plated carbon steel heavy hexagonal head nuts, epoxy coated
Gaskets	All	3 mm thick full-faced premium grade EPDM for [SBS, CLS] services. 3mm thick full-faced, premium grade Teflon encapsulated EPDM for [SH,] services. 3 mm thick full-faced premium grade Neoprene for other services.
Buried Piping	All	Solvent welded joints.
Piping	All	Piping system to withstand pressures to 1050 kPa and temperatures from -30°C to 82°C, unless otherwise specified.

## 2.5 Type 304L (ASTM A778) Stainless Steel – SS

### Data Sheet No. SS1

ITEM	SIZES (mm)	GENERAL DESCRIPTION
Pipe	80 to 900	Schedule 10S Type 304L stainless steel conforming to ASTM A778 and ANSI B36.19, seamless or welded, pickled.
Fittings	80 - 900	Schedule 10S Type 304L stainless steel, butt-welded, smooth flow long radius elbows, caps and reducers conforming to ASTM A774 and ANSI B16.9.
Branches	In piping 80 - 900	Schedule 10S Type 304L stainless steel, butt welded, smooth flow tees, conforming to ASTM A774, with weldolets, threaded couplings conforming to ASTM A182, Class 3000, 304L stainless steel.
Stub-End	80 to 900	Schedule 10S Type 304L stainless steel stub-end, butt-welded, conforming to ASTM A774.
Flanges	80 - 600	Type 304L stainless steel, ANSI B16.5, Class 150, weld neck, flanges bored for Schedule 10S pipe conforming to ASTM A778.  Schedule 10S Type 304L stainless steel stub-end conforming to ASTM A774 with lap joint flange drilled to ANSI B16.5 Class 150, hot-dip galvanized in T2 thickness or AWWA Class "D" rated flange.
Blind Flanges	80 - 600	Schedule 10S Type 304L stainless steel, conforming to ASTM A774, drilled to ANSI B16.5 Class 150.
Bolts	All	Type 304L stainless steel ASTM A-193/193M Grade B8M heavy hexagonal machine bolts, scale free, shiny stainless steel finish.
Nuts	All	Type 304L stainless steel ASTM A194/194M, B8M hexagonal nuts, scale free, shiny stainless steel finish.
Gaskets	All	3 mm thick full-faced premium grade Neoprene.
Welding	All	In accordance with Section 15051.
Piping	All	Piping system to withstand pressures to 1050 kPa and temperatures from -30°C to 82°C, unless otherwise specified in Table 1.

## 2.6 Type 304L (ASTM A778) Stainless Steel – SS (Victaulic Joints)

Data Sheet No. **SS2**

ITEM	SIZES (mm)	GENERAL DESCRIPTION
Pipe	80 - 900	Schedule 10S Type 304L stainless steel conforming to ASTM A778 and ANSI B36.19, seamless or welded, pickled. Groove pipe ends to rigid radius groove conforming to ANSI/AWWA C-606.
Pipe Design	All	To CSA B242 for radius grooved and shoulder type mechanical pipe couplings.
Fittings	80 - 900	Schedule 10S Type 304L stainless steel, long radius elbows, caps and reducers conforming to ASTM A774 Grade WP and ANSI B16.9. Groove ends conforming to ANSI/AWWA C-606.
Branches	In piping 80 to 600	Schedule 10S Type 304L stainless steel butt welded smooth flow tees conforming to ASTM A774 with re-pad to B31 or weldolets conforming to ASTM A-182 Grade F316L Groove ends to rigid radius groove conforming to ANSI/AWWA C-606.
Flanges	80 to 900	Type 304L stainless steel ANSI B16.5 Class 150 weld neck Flanges, bored for Schedule 10S pipe, conforming to ASTM A182.  Schedule 10S Type 304L stainless steel stub-end collar conforming to ASTM A774 with backing ring flange, drilled to ANSI B16.5 Class 150, hot-dip galvanized in T2 thickness or AWWA Class "D" rated flange.
Blind Flanges	80 - 600	Schedule 10S Type 304L stainless steel, conforming to ASTM A774, drilled to ANSI B16.5 Class 150.
Joints	80 to 900	Joints to be welded, flanged or Victaulic Roll-Groove (Style #77 for flexible, Style #89/W89 for rigid rated to 300psi). Contact Victaulic for applicable psi ratings of flexible joints. All welds to be full penetration and all welders to be certified by the TSSA.
Couplings at building expansion joints	80 - 300 350 - 600	Victaulic Style 77 on flexible radius grooved pipe.  Victaulic Style W77 on flexible advanced grooved pipe.
Couplings (General)	80 - 300 350 - 600	Victaulic Style 89 on rigid radius grooved pipe.  Victaulic Style W89 on rigid advanced grooved pipe.
Identification	All	Differential rigid joint from flexible joint by color code identification.
Bolts	All	Type 304L stainless steel ASTM A194/194M, B8M hexagonal nuts, scale free, shiny stainless steel finish.
Nuts	All	Type 304L stainless steel ASTM A194/194M, B8M hexagonal nuts, scale free, shiny stainless steel finish.
Gaskets	All	3 mm thick full-faced premium grade Neoprene
Welding	All	In accordance with Section 15051.
Piping	All	Piping system to withstand pressures to 1050 kPa and temperatures from -30°C to 82°C, unless otherwise specified in Table 1.

## 2.7 Type 316L (ASTM A312) Stainless Steel – SS (Victaulic Joints)

Data Sheet No. SS5

ITEM	SIZES (mm)	GENERAL DESCRIPTION
Pipe	80 - 900	Schedule 10S Type 316L stainless steel conforming to ASTM A312 and ANSI B36.19, seamless or welded, pickled. Groove pipe ends to rigid radius groove conforming to ANSI/AWWA C-606.
Pipe Design	All	To CSA B242 for radius grooved and shoulder type mechanical pipe couplings.
Fittings	80 - 900	Schedule 10S Type 316L stainless steel, long radius elbows, caps and reducers conforming to ASTM A403 Grade WP and ANSI B16.9. Groove ends conforming to ANSI/AWWA C-606.
Branches	In piping 80 to 600	Schedule 10S Type 316L stainless steel butt welded smooth flow tees conforming to ASTM A304 with re-pad to B31 or weldolets conforming to ASTM A-182 Grade F316L Groove ends to rigid radius groove conforming to ANSI/AWWA C-606.
Flanges	80 to 900	Type 316L stainless steel ANSI B16.5 Class 150 weld neck Flanges, bored for Schedule 10S pipe, conforming to ASTM A182.  Schedule 10S Type 316L stainless steel stub-end collar conforming to ASTM A403 with backing ring flange, drilled to ANSI B16.5 Class 150, hot-dip galvanized in T2 thickness or AWWA Class "D" rated flange.
Blind Flanges	80 - 600	Schedule 10S Type 316L stainless steel, conforming to ASTM A403 with flange drilled to ANSI B16.5 Class 150.
Joints	80 to 900	Joints to be welded, flanged or Victaulic Roll-Groove (Style #77 for flexible, Style #89/W89 for rigid rated to 300psi). Contact Victaulic for applicable psi ratings of flexible joints. All welds to be full penetration and all welders to be certified by the TSSA.
Couplings at building expansion joints	80 - 300 350 - 600	Victaulic Style 77 on flexible radius grooved pipe.  Victaulic Style W77 on flexible advanced grooved pipe.
Couplings (General)	80 - 300 350 - 600	Victaulic Style 89 on rigid radius grooved pipe.  Victaulic Style W89 on rigid advanced grooved pipe.
Identification	All	Differential rigid joint from flexible joint by color code identification.
Bolts	All	Type 316L stainless steel ASTM A-193/193M Grade B8M heavy hexagonal machine bolts, scale free, shiny stainless steel finish.
Nuts	All	Type 316L stainless steel ASTM A194/194M, B8M hexagonal nuts, scale free, shiny stainless steel finish. service).
Gaskets	All	3 mm thick full-faced premium grade Neoprene
Welding	All	In accordance with Section 15051.
Piping	All	Piping system to withstand pressures to 1050 kPa and temperatures from -30°C to 82°C, unless otherwise specified in Table 1.

## 2.8 Welding Materials

- .1 Use welding materials conforming to CSA W48.1.
- .2 Provide electrodes compatible with material welded that deposit metal with strength and corrosion resistance properties equivalent to base metal.

## 2.9 Flange/Coupling Spacing

- .1 Refer to Section 15050 for additional flange, union, and coupling requirements in piping systems not specified in this Section or shown on drawings.

## 2.10 Flexible Couplings

- .1 Provide flexible couplings as follows:
  - . 1 Flexible sleeve type couplings:
    - .1 Type: cylindrical centre ring, two follower rings, two resilient gaskets, and connecting bolts.
    - .2 Acceptable manufacturers:
      - .1 Dresser Style 38.
      - .2 Robar 1408.
  - . 2 Flanged flexible sleeve type couplings:
    - .1 Type: Flanged cylindrical centre ring, companion flange, one follower ring, resilient gasket, and connecting bolts.
    - .2 Acceptable manufacturers:
      - .1 Dresser Style 128.
      - .2 Robar 7808.
  - . 3 Transition flexible sleeve type couplings:
    - .1 Type: Stainless Steel to PVC pipe couplings to be restrained flexible style MULTI/JOINT® 3007 style or approved equal. All bolts, washers nuts shall be wrapped in Denso Tape, paste mastic and tape or approved equal.
    - .2 Acceptable manufacturers:
      - .1 Georg Fischer.
      - .2 Approved Equal.
  - . 4 Centre ring: steel, shop coated for corrosion protection.
  - . 5 Gaskets: fabricated of material suitable to service conditions.

- . 6 Submerged, buried or below structure applications: use stainless steel bolts, nuts and washers.
- . 7 Provide necessary amount and appropriate size of restraining rods and gussets as recommended by manufacturer.
- . 8 Type 1 - Restrained; use flexible sleeve-type coupling with restraining rods, and gussets welded to pipe. Provide sufficient restraint to resist pressure equal to twice system test pressure.
- . 9 Do not use Type I flexible couplings in pipe systems which undergo thermal expansion and contraction; do not use these couplings at structural joints.

### **2.11 Steel Supports**

- .1 Hollow structural steel or aluminum supports for piping, where indicated on Drawings or as required, are provided under Division 5. Provide roller supports and accessories for piping in accordance with Section 15050, 15060 Clause 1.1, 15070 and drawing details.

### **2.12 Instrument Vent Lines**

- .1 Services: All.
- .2 Vent lines, for instruments supplied under Division 16 and installed under this Section, are generally not indicated on Drawings.
- .3 Installation: in accordance with manufacturer's requirements and to CAN/CGA-B105 for digester gas systems.
- .4 Vent line material for instruments: Schedule 40S Type 316L stainless steel tubing. Data Sheet SS5.

### **2.13 Wet Well & Chamber Vents**

- .1 Fit wet well vents with bug screens and provide screwed or flanged ends to attach odour control valves, and portable ventilation equipment.
- .2 Fit chamber vent with ends compatible with portable ventilation equipment.

### **2.14 Drain Points**

- .1 Services: All.
- .2 Horizontal pipes: 25 mm drain point with Schedule 40S Type 316L stainless steel NPS pipe, manual ball valve, and nipple. Valves are supplied under Section 15100.
- .3 Locations:
  - . 1 Install drain point on bottom of horizontal pipe at low points in process piping system.
  - . 2 Where indicated on Drawings. Drawings may not indicate all required drain point locations.

### **2.15 Magnetic Meter Spool Pieces**

- .1 Provide make up spool pieces of same material as piping system for following piping systems:

Services	Diameter (mm)	Quantity
RWW	150	1 – Magnetic Flowmeter

## 2.16 Quick Disconnects

- .1 Quick disconnects:
- . 1 Designed to not disconnect under pressure.
- .2 Air services:
- . 1 Dust caps with quick disconnect.
  - . 2 Manufacturers: Swage Lok Full Flow QF Series, Tomco THK.
  - . 3 Size: 12 mm diameter.
- .3 Water services:
- . 1 For ≤50mm diameter: Camlock, four lug, malleable iron, female NPT supplied by Dixon Airking.
  - . 2 For 80mm to 100mm diameter: quick-acting, dual clip supplied by Dixon or Rite-Pro.
- .4 Chemical services:
- . 1 Manufacturers: Bay Seal, Dixon Boss Lock, PT Couplings.

## 2.17 Grooved Pipe Couplings

- .1 Provide following grooved pipe couplings for specified piping system in Table 15060-1:
- . 1 Manufacturer's: Victaulic Company.
  - . 2 Materials: ASTM A-47, Grade 32510 or 35108.
  - . 3 Design: CSA B242 for radius grooved and shoulder type mechanical piping couplings.
  - . 4 Method: Rigid Joint method on HDPE, ductile iron, steel, carbon steel, galvanized carbon steel, and stainless steel piping systems.
  - . 5 Pipe ends: Grooved to ANSI/AWWA C-606 and manufacturer's recommendations to make connections rigid.

- . 6 Differentiate Rigid Joint from Victaulic Flexible Joint by colour code identification.
- . 7 Style 31 Victaulic couplings on flexible radius grooved ductile iron pipe when pipe crosses structural expansion joints.

**2.18 Pipe Couplings**

- .1 Connect new pipes to existing pipes
- .2 existing pipes where flanged connections are not possible with:
- .3

- . 1 Services: All.
- . 2 Bolts: Type 316 stainless steel ASTM A-193 Grade B8A.
- . 3 Nuts: Type 316 stainless steel ASTM A-194 Grade B.
- . 4 Coupling materials: Ductile iron ASTM A-536.
- . 5 Other: Coupling suitable for connecting new pipe to existing cast iron, ductile iron, stainless steel or carbon steel pipes. Groove existing pipe end to make connection rigid.
- . 6 Manufacturers: Victaulic Pipe Company.
- . 7 Model: Victaulic Coupling Style 89, W89, W07.

**2.19 Puddle Flanges**

- .1 Use minimum 6.35mm thick steel plate as puddle flange material with diameters as follows:

PIPE DIAMETER	PUDDLE FLANGE DIAMETER
75 mm to 300 mm	Pipe diameter plus 50 mm
350 mm to 550 mm	Pipe diameter plus 100 mm
600 mm and larger	Pipe diameter plus 150 mm

- . 1 Bolts: Type 316 stainless steel ASTM A-193 Grade B8A.
- . 2 Nuts: Type 316 stainless steel ASTM A-194 Grade B.

**2.20 Wall Seals**

- .1 Services: All.
- .2 Type: wall penetration seals, non-insulating.
- .3 Sealing element: EPDM rubber.
- .4 Bolts, nuts, washers and pressure plates: Type 304 stainless steel.

- .5 Pressure rating: 1050 kPa static head.
- .6 Temperature rating: 40°C.
- .7 Pipe size: as indicated on Drawings.
- .8 Number required: on one side of wall.
- .9 Manufacturers: Link-seal.

## 2.21 Gaskets

- .1 Flat-faced type: use full-face gaskets.
- .2 Raised-faced type: use ring type gaskets.
- .3 Gaskets conforming to ASTM B16.21.
- .4 Provide gaskets for flanged connections suitable for specified temperature and pressure ranges and for corrosive properties of fluid in pipeline.
- .5 Gasket material
  - . 1 EPDM: ethylene-propylene-diene-terpolymer 70 durometer.
  - . 2 Neoprene: neoprene (black) 70 durometer.
  - . 3 Nitrile: nitrile (Buna N).
  - . 4 SBR: styrene-butadiene (red).
  - . 5 Natural rubber: natural rubber.
  - . 6 Compressed synthetic fibres (Kevlar): ASTM F104 (F712400), and neoprene binder: 1.7 MPa (ASTM F152) 0.2 mL/h leakage fuel A (ASTM F37).
- .6 Minimum gasket thickness for full-faced gaskets, unless otherwise specified:
  - . 1 <150mm pipe diameter: 1.6mm thick.
  - . 2 ≥150mm pipe diameter: 3.0mm thick.
- .7 Minimum gasket thickness for raised-faced gaskets, unless otherwise specified:
  - . 1 <150mm pipe diameter: 1.6mm thick.
  - . 2 ≥150mm pipe diameter: 3.0mm thick.
- .8 Grooved joint gasket material: recommended by coupling manufacturer.

## 2.22 Galvanizing

- .1 Hot dip zinc coat galvanized to CSA G164 with minimum coating of 550 g/m<sup>3</sup> where piping is

specified to be galvanized.

### **3.0 EXECUTION**

#### **3.1 Finishes**

- .1 Prepare surfaces and shop prime ferrous piping and appurtenances in accordance with Section 09900.
- .2 Do not paint stainless steel.

#### **3.2 Preparation**

- .1 Prepare piping to Section 15050.

#### **3.3 Examination**

- .1 Report construction defects in writing to Engineer before proceeding with work that will affect work of this Section. Proceed after conditions are acceptable to Engineer.

#### **3.4 Sleeves**

- .1 Install pipe sleeves to Section 15050.

#### **3.5 Insulation**

- .1 Piping is insulated under Sections 02600 and 15250, as applicable.

#### **3.6 Connecting Dissimilar Piping Systems**

- .1 Provide dielectric fittings and/or adapting flanges and couplings to connect dissimilar metals such as steel and stainless steel in accordance with Section 15050.

#### **3.7 Expansion Joints**

- .1 Accurately align pipelines to receive expansion joints before installing joint.
- .2 Do not stretch, compress or offset joint to fit piping.
- .3 Align and install expansion joint in accordance with EJMA standards and with manufacturer's written instruction; properly guide and anchor expansion joints. No lateral movement is permitted on compensator expansion joints.
- .4 On rubber expansion joints, check bolt tightness, and tighten where necessary one week after commissioning.

#### **3.8 Pipe Installation**

- .1 Install piping systems in accordance with Section 15050.
- .2 Additional installation requirements for chemical piping systems:

- . 1 Maximum union spacing: 7 metre intervals and in each room.
- . 2 Design: allow for thermal expansion in long lengths of PVC pipe.
- . 3 Install piping, where possible, to permit drainage back to low point in building. Provide additional valves for drainage.
- . 4 Provide tees and screwed drain plugs at low and high points in piping or vents and drainage.
- . 5 Maximum vertical piping supports: 1.5 m with supports with broad smooth surfaces.
- . 6 Align and support piping to avoid excessive stresses.

### **3.9 Cleaning**

- .1 Pipe cleaning: In accordance with Section 15050 and Division 1.
- .2 Replace equipment damaged during initial operating period due to foreign material not removed from piping systems.
- .3 Clean piping systems of slag and foreign material by blowing with clean compressed air before connecting piping to valves, meters, instruments, and equipment.
- .4 Additional cleaning requirements for air piping systems: .
  - . 1 Clean piping system free of dust, dirt and debris after successful pressure testing of piping system.
  - . 2 Clean pipe in sections so that air velocity in each pipe section being cleaned is minimum 8 m/sec.

### **3.10 Field Tests**

- .1 Test piping systems in accordance with Section 15050, ANSI B31.1-137.3, 137.4 as applicable and Table 1 specified under this Section.
- .2 Valves, provided under Section 15100, under this Section as integral part of piping field tests.

### **3.11 Yard Piping**

- .1 Installation of yard piping: In accordance with Section 02600.

### **3.12 Protection**

- .1 Protect installed work from dust, contamination and damage prior to acceptance by the Engineer.

### **3.13 Existing Pipe Cleaning**

- .1 Flush existing pipe, scheduled to be reused where connected to new piping, free of waste material. Clean existing pipe with high-pressure pipeline washing equipment.

- .2 Provide required fittings, temporary pipe connections and other similar items for high pressure wash cleaning.
- .3 Submit cleaning procedures to Engineer for review well in advance of work.

**End of Section**

## 15070 Piping Supports

### 1.0 General

#### 1.1 Section Includes

- .1 This Section covers the Work of designing, fabrication and installation of pipe support systems.
- .2 All support is to be Post Disaster rated as required by the Ontario Building Code.

#### 1.2 Design Codes and Standards

- .1 The following is a list of standards which may be referenced in this Section:
  - .1 American Society for Testing and Materials (ASTM): A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
  - .2 American Society for Testing and Materials (ASTM): A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc Iron Alloy Coated (Galvanealed) by the Hot Dip Process.
  - .3 Building Officials and Code Administrators (BOCA): Basic Building Code.
  - .4 International Conferences of Building Officials (ICBO): Uniform Building Code.
  - .5 National Building Code of Canada (NBC)
  - .6 Ontario Building Code (OBC).
  - .7 Manufacturers' Standardization Society (MSS):
    - .1 SP-58, Pipe Hangers and Supports - Materials, Design and Manufacture.
    - .2 SP-69, Pipe Hangers and Supports - Selection and Application.
    - .3 SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
    - .4 Note that additional provisions, beyond those listed herein, will be required to make the process piping support system compliant with seismic design and Post Disaster level of service required by the Municipality of Southwest Middlesex Building Officer. The Constructor will be responsible for the design and supply of materials to make the piping support system compliant with Post Disaster Design level of service.

#### 1.3 Submittals

- .1 Submit shop drawings in accordance with Section 01300, Submittals.
- .2 Shop Drawings
- .3 Design Calculations:
  - .1 Design calculations include but not limited to support/hanger spans, loads, movements, numbers of supports/hangers and types of supporting and anchoring, etc.
  - .2 All calculations shall be stamped by a Professional Engineer in Ontario.
- .4 Design Drawings:
  - .1 Layout and/or section drawings showing the pipe support systems in accordance with the piping layouts as provided in the Contract Drawings.

- .2 Show on the drawings the product types and model numbers, methods of construction, explanatory notes and other information necessary for proper performance of the Work. Identify by cross-references to design drawings and Specifications.
- .3 All drawings shall be stamped by a Professional Engineer in Ontario.
- .5 Product Data:
  - .1 Specifications, catalogue cuts, technical data, and descriptive literature include details of materials, dimensions, shape, and model numbers. Selected products shall be clearly indicated on the product data sheets.
  - .2 Product Data shall include a listing of the intended use and general location of each item submitted.
  - .3 After installation a professional engineer licensed in the Province of Ontario shall complete a site review and then submit a letter, sealed and signed, stating that the pipe support(s) are installed as per Building Code.
  - .4 Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
  - .5 Information Submittals: Maintenance information on the piping support system.
- .6 Where piping systems are subject to thrust forces, thrust blocks and ties at pipe joints are required.

#### 1.4 Design Requirements

- .1 General
  - .1 Pipe supports, hangers, struts and anchors that have been indicated on the Contract Drawings, are for demonstration purpose but no attempt has been made to indicate the entire pipe support details. It shall be Contractor's responsibility to provide a complete system of pipe supports and to anchor all piping, in accordance with the design by the Supplier and the requirements specified within.
  - .2 It shall be Contractor's responsibility to provide additional pipe supports that may be required adjacent to expansion joints, couplings, or valves according to field installation situations, should no such details are shown in the drawings.
  - .3 Typical and minimum requirement of piping supports are shown in the drawings and this specification. The Contractor/Designer shall provide sizes and design the piping supports to meet the minimum requirement.
  - .4 Design pipe supports(s) and anchorage for vertical and lateral loading in accordance with the Ontario Building Code Division. Co-ordinate all support from pre-engineered building with building supplier.
  - .5 Design, size, and locate piping support systems throughout the facility, whether shown or not, in order to meet the requirements of Ontario Building Code.
  - .6 Piping smaller than 350mm: Supports are shown to indicate specific types, additional pipe supports are required by the Contractor, to suit specified spans and component requirements.
  - .7 Meet the requirements of MSS SP-58, MSS SP-69, and MSS SP-89, or as modified by this Section.
  - .8 Alternate piping systems, proposed by the Contractor, shall be analysed and designed by a professional engineer engaged by and paid for by the Contractor. Such piping systems shall be provided with thrust blocks, ties and/or other restraint systems required to resist internal and external forces on the piping system. The design shall provide the Consultant with information on lateral deflection, axial

- strain and any resulting unbalanced forces on equipment or connecting piping systems.
- .9 All supports, hangers, struts and anchors must be compliant with Post Disaster Design level of service.
- .2 Pipe Support Systems
- .1 Select and design within the specified spans and component requirements.
- .2 The absence of pipe supports and details on the Drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout the project, plant, etc.
- .3 Meet the requirements of ANSI/MSS SP-58, "Pipe Hangers and Supports Materials, Design, and Manufacture."
- .4 Criteria for Structural Design and Selection of Pipe Support System Components:
- .1 Dead loads imposed by the weight of the pipes filled with water, except air and gas pipes within the specified spans and component requirements, plus any insulation.
- .2 Safety factor: Minimum of 5.
- .5 Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor the support, to withstand the shear and pullout loads imposed by loading and spacing on each particular support.
- .1 Piping smaller than 350mm: Supports may be shown to indicate specific types; additional pipe supports is required to suit specified spans and components.
- .6 Framing Support System
- .1 Beams: Size such that beam stress does not exceed 25,000 psi and maximum deflection does not exceed 1/240 of span.
- .2 Column Members: Size in accordance with the manufacturers recommended method.
- .7 Materials
- .1 Unless otherwise specified or indicated on the drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish unless noted otherwise.
- .2 Design loads for inserts, brackets, clamps and other support items shall not exceed the manufacturer's recommended loads.
- .3 Pipe supports shall be manufactured for the sizes and type of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 300mm (12 inches) in length.
- .4 Unless otherwise acceptable to Contract Administrator, the use of supports which rely on stressed thermoplastic components to support the pipe will not be acceptable.
- .5 Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.
- .6 No copper pipe, brass pipe or copper tubing shall contact a pipe support or hanger of dissimilar metal. Hangers and supports shall be copper-plated, plastic coated, or pipe shall be galvanically isolated using Neoprene strips or other material as approved.

- .7 Appropriate materials and protective coatings shall be used (stainless steel, galvanized steel or FRP) to prevent failure from environmental, galvanic corrosion and chemical corrosion.

**1.5 Thrust Restraint**

- .1 Thrust Blocks and Ties: Generally not shown on the Drawings of the individual pipelines; their absence shall not relieve the Contractor of the responsibility for providing them, as required to provide complete systems.

**1.6 Acceptable suppliers and/or manufacturers**

- .1 Anvil International Canada
- .2 Cooper B Line Inc.
- .3 L.E. Taylor Associates Ltd.
- .4 E. Myatt & Co. Inc.

**1.7 Pipe Support Spacing and Maximum Rod Sizes**

- .1 The maximum allowable spacing for pipe hangers shall be in accordance with Hanger Locations and Spacing recommended by manufacturers pipe material being used and as follows.
- .2 Lateral Supports: Tie-rods in two directions and combined tension/compression members designed and spaced to meet the specified Code requirements, listed in Subsection 1.2.
- .3 All Vertical Supports: Mild Steel or Ductile Iron Piping (Note that this spacing may require the use of higher load pipe clamps and more than a single point anchor point in concrete):

Pipe Size	Max. Support/Hanger Spacing	Min. Rod Size Single Rod Hangers
25mm & smaller	1.8m	6.25mm
32.5mm to 62.5mm	2.4m	6.25mm
75mm & 100mm	3.0m	9.5mm
150mm	3.6m	9.5mm
200mm	3.6m	12.5mm
250mm & 300mm	4.3m	15.9mm
350mm	4.8m	19.1mm
400mm & 450mm	4.8m	22.2mm
500mm	5.4m	25.4mm
600mm	5.4m	31.7mm
750mm & larger	As shown on the drawings	As shown on the drawings

- .4 Copper Piping:
  - .1 Maximum Support Spacing: 0.61m less per size than listed for steel pipe, with 25.4mm and smaller pipe supported every 1.5m.
  - .2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.
- .5 Plastic Piping:
  - .1 Maximum support spacing: As recommended by the manufacturer for the flow temperature in pipe.
  - .2 Minimum Hanger Rod Sizing: Same as listed for steel pipe.
- .6 Rubber Hose and Flexible Tubing:
  - .1 Rubber Hose and Flexible Tubing shall be provided with continuous angle or channel support. The absence of pipe supports and details on the Drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout the project, plant, etc.

.7 Stainless Steel Piping:

Pipe Size	Max. Support Hanger/Spacing	Min. Rod Size Single Rod Hangers
25mm through 100mm	2.4m	6.25mm
150mm	2.4m	9.5mm
200mm & 250mm	3.0m	12.5mm
300mm	3.0m	12.5mm
350mm & 400mm	3.6m	15.9mm
450mm & 500mm	4.3m	19.1mm
600mm	4.3m	22.2mm
750mm & larger	As shown on the drawings	As shown on the drawings

- .8 Framing Support System:
  - .1 Beams: Size such that beam stress does not exceed 172,000 kPa and maximum deflection does not exceed 1/240 of span.
  - .2 Column Members: Size in accordance with the manufacturer's recommended method.
  - .3 Support Loads: Calculate using weight of pipes filled with water.
  - .4 Maximum Spans:
    - .1 Steel and Ductile Iron Pipe, 75mm Diameter and Larger: 3m centres, unless otherwise shown on the Drawings.
    - .2 Other Pipelines and Special Situations: May require supplementary hangers and supports.
- .9 Electrical Conduit Support: Include in design of framing support system.

- .10 Existing Support Systems: Use existing supports systems to support new piping only if the Contractor can show that they are adequate for additional load, or if they are strengthened to support additional load.
- .11 Unless otherwise indicated on the drawings or acceptable to Contract Administrator, piping shall be supported approximately 38mm (1½ inches) out from the face walls and at least 75mm (3 inches) below ceilings.

## **2.0 PRODUCTS**

### **2.1 General**

- .1 When specified items are not available, fabricate pipe supports of the correct material and to the general configuration indicated by catalogues.
- .2 Special support and hanger details are shown for cases where standard catalogue supports are inapplicable.

### **2.2 Hangers**

- .1 Clevis Type: MSS SP-58 and SP-69, Type 1 or 6.
  - .1 Anvil International Inc.; Figure 104 or 260.
  - .2 Cooper B Line Inc.; Figure B3198 or B3100.
- .2 Adjustable Swivel Ring: MSS SP-58 and SP-69, Type 10.
  - .1 Cooper B Line Inc.; Figure B3170.
- .3 Hinged Split Ring Pipe Clamp: MSS SP-58 and SP-69, Type 6 or 12.
  - .1 Anvil International Inc.; Figure 104.
  - .2 Cooper B Line Inc.; Figure B3198H.
- .4 Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.
- .5 Attachments:
  - .1 I Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.
  - .2 Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of the hanger rod it supports.

### **2.3 Saddle Supports**

- .1 Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
- .2 Nonadjustable Saddle: MSS SP-58 and SP-69, Type 37 with U bolt.
  - .1 Anvil International Inc.; Figure 259.
  - .2 Cooper B Line Inc.; Figure B3090.
- .3 Adjustable Saddle: MSS SP-58 and SP-69, Type 38 without clamp.
  - .1 Anvil International Inc.; Figure 264.
  - .2 Cooper B Line Inc.; Figure B3093.

### **2.4 Wall Brackets**

- .1 Welded Steel Bracket: MSS SP-58 and SP-69, Type 33 (heavy-duty).

- .1 Anvil International Inc.; Figure 199.
- .2 Cooper B Line Inc.; Figure B3067.
- .2 One Hole Clamp: Anvil International Inc.; Figure 126.

## 2.5 Pipe Clamps

- .1 Riser Clamp: MSS SP-58 and SP-69, Type 8.
  - .1 Anvil International Inc.; Figure 261.
  - .2 Cooper B Line Inc.; Figure B3373.
- .2 Strap: MSS SP-58 and SP-69, Type 26.
  - .1 Cooper B Line Inc.; Figure B2400.

## 2.6 Accessories

- .1 Insulation Shields:
  - .1 Type: Galvanized steel or stainless steel, MSS SP-58 and SP-69, Type 40.
  - .2 Manufacturers and Products:
    - .1 Anvil International Inc.; Figure 167.
    - .2 Cooper B Line Inc.; Figure B3151.
- .2 Welding Insulation Saddles:
  - .1 Type: MSS SP-58 and SP-69, Type 39.
  - .2 Manufacturers and Products:
    - .1 Anvil International Inc.; Figure Series 160.
    - .2 Cooper B Line Inc.; Figure Series B3160.
- .3 Vibration Isolation Pads:
  - .1 Type: Neoprene Waffle.
  - .2 Manufacturers and Products:
    - .1 Mason Industries Inc.; Type W.
    - .2 Korfund Dynamics (division of Aeroflex Inc.); Korpad 40.
- .4 Flush Type Insert Channels: As specified.

## 2.7 Pipe Guides

- .1 Intermediate Guides:
  - .1 Piping 150mm and smaller: specify the use of pipe clamp with oversize pipe sleeve to provide a minimum of 3mm of clearance.
    - .1 Manufacturers:
      - .1 Kin Line, Inc., Figure 417.
      - .2 Grinnell (Division of Tyco Fire products LP): Power Strut Figure P5932.
  - .2 Piping 200 mm and Larger: Specially formed U bolts with double nuts to provide a minimum clearance of 6 mm around pipe.
    - .1 U Bolt Stock Sizes:
      - .1 200 mm Pipe: 16mm U bolt.
      - .2 250 mm Pipe: 400mm U bolt.

- .3 300 through 400mm Pipe: 22mm U bolt.
- .4 450 through 760mm Pipe: 25mm U bolt.
- .2 Intermediate Guides:
  - .1 Piping 200mm and Smaller: Galvanized steel spider or sleeve type.
  - .2 Piping 250mm and Larger: Galvanized roller type guides.
  - .3 Manufacturers:
    - .1 Vibrant Power Inc.
    - .2 Senior Flexonics Canada Ltd.
    - .3 Kin-Line Inc.

## 2.8 Pipe Anchors

- .1 Type: Galvanized steel anchor chair with U bolt strap.
- .2 Manufacturers and Products:
  - .1 Anvil International Inc.
  - .2 Cooper B Line Inc.; Figure B3147A or B3147B.
- .3 Size: Sized by the equipment manufacturer, but using 12.7mm minimum diameter, and as specified in Section 05500 - Metal Fabrications (Basic).
- .4 The following are not acceptable or permitted;
  - .1 Wire hangers.
  - .2 Perforated strap.
  - .3 Hanging from unreinforced metal roof deck.
  - .4 Hanging from cellular roof deck
  - .5 Wood plugs.
  - .6 Soft insulation at point of support of cold lines.

## 3.0 EXECUTION

### 3.1 Installation

- .1 General
  - .1 Install support systems in accordance with MSS SP 69 and MSS SP 89, unless shown otherwise on the Drawings.
  - .2 All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, adjacent to flexible couplings and where otherwise shown. Pipe supports and hangers shall not be installed in equipment access areas or bridge crane runs.
  - .3 Support piping connections to equipment by pipe support and not by equipment.
  - .4 Support large or heavy valves, fittings, and appurtenances independently of connected piping.
  - .5 Support no pipe from the pipe above it.
  - .6 Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after start-up.

- .7 Anchorage shall be provided to resist both lateral and longitudinal seismic forces. Seismic forces shall be calculated assuming the pipes are full.
- .8 Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
- .9 Repair mounting surfaces to their original condition after attachments are made.
- .2 Standard Pipe Supports:
  - .1 Horizontal Suspended Piping:
    - .1 Single Pipes: Adjustable swivel ring, split ring, or clevis hangers.
    - .2 Grouped Pipes: Trapeze hanger systems.
    - .3 Furnish galvanized steel protection shield and oversized hangers for insulated pipe.
    - .4 Furnish pre-cut sections of rigid insulation with vapour barrier at hangers for insulated pipe.
  - .2 Horizontal Piping Supported From Walls:
    - .1 Single Pipes: Wall brackets or wall clips attached to wall with anchors. Clips attached to wall mounted framing also acceptable.
    - .2 Stacked Piping:
      - .1 Wall mounted framing system and clips acceptable for piping smaller than 75mm minimal diameter.
      - .2 Piping clamps that resist axial movement of pipe through support are not acceptable.
    - .3 Wall mounted piping clips not acceptable for insulated piping.
    - .4 Horizontal Piping Supported From Floors:
      - .1 Stanchion Type:
        - .1 Pedestal type; adjustable with stanchion, saddle, and anchoring flange.
        - .2 Use yoked saddles for piping whose centreline elevation is 450mm or greater above floor and for exterior installations.
        - .3 Provide neoprene waffle isolation pad under anchoring flanges, adjacent to equipment or where otherwise required to provide vibration isolation.
      - .2 Floor Mounted Channel Supports:
        - .1 Use for piping smaller than 75mm nominal diameter running along floors and in trenches at piping elevations lower than can be accommodated using pedestal pipe supports.
        - .2 Attach channel framing to floors with anchor bolts.
        - .3 Attach pipe to channel with clips or pipe clamps.
      - .3 Concrete Cradles: Use for piping larger than 75mm along floor and in trenches at piping elevations lower than can be accommodated using stanchion type.
  - .5 Vertical Pipe: Support with wall brackets and base elbow or riser clamps on floor penetrations.
  - .6 Standard Attachments:
    - .1 To Concrete Ceilings: Concrete inserts.
    - .2 To Steel Beams: I beam clamp or welded attachments.
    - .3 To Wooden Beams: Lag screws and angle clips to members not less than 62.5mm thick.

- .4 To Concrete Walls: Concrete inserts or brackets or clip angles with anchor bolts.
- .7 Intermediate and Pipe Alignment Guides:
  - .1 Provide pipe alignment guides (or pipe supports that provide same function) at expansion joints and loops.
  - .2 Guide piping on each side of expansion joint or loop at 4 and 14 pipe diameters from each joint or loop.
  - .3 Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.
- .8 Accessories:
  - .1 Insulation Shield: Install on insulated non-steel piping. Oversize rollers and supports.
  - .2 Welding Insulation Saddle: Install on insulated steel pipe. Oversize rollers and supports.
  - .3 Vibration Isolation Pad: Install under base flange of pedestal type pipe supports adjacent to equipment, and where required to isolate vibration.
    - .1 Dielectric Barrier: Install between carbon steel members and copper or stainless steel pipe.
    - .2 Install between stainless steel supports and non-stainless steel ferrous metal piping.
- .9 Electrical Isolation: Install 6.4mm by 75mm neoprene rubber wrap between submerged metal pipe and oversized clamps.

### 3.2 Field Finishing

- .1 Paint: As specified in Section 09900, Painting; if included in spec sections.

**End of Section**

## 15100 Process Valves

### 1.0 General

#### 1.1 Summary

- .1 Section includes supply, installation, testing, training, cleaning and placing into operation of process valves and accessories.
- .2 Note that additional provisions, beyond those listed herein, will be required to make the process valve supports compliant with seismic design and Post Disaster level of service required by the Municipality of Middlesex Centre Chief Building Officer. The Constructor will be responsible for the design and supply of materials to make the support frames compliant with Post Disaster Design level of service.

#### 1.2 Related Sections

- |    |                  |                               |
|----|------------------|-------------------------------|
| .1 | Section 15050    | Mechanical General Provisions |
| .2 | Section 02600    | Underground Piping            |
| .3 | Section 11050    | Process General Provisions    |
| .4 | Division 1       | General Requirements          |
| .5 | Division 16      | Electrical                    |
| .6 | Section 16 05 81 | Motors and Actuators          |

#### 1.3 Submittals

- .1 Submit shop drawings, manuals, parts lists, etc. in accordance with Sections 01300 and 01730.
- .2 Shop drawings
  - .1 Manufacturer's product data including catalogue cuts for specified submittals.
  - .2 Manufacturer's installation instructions for specified submittals.
  - .3 Drawings showing details, dimensions, materials of construction, head loss characteristics through valve, operating torque, valve end configurations, and standards for specified submittals.
  - .4 Valves: 25 mm in diameter and larger.
  - .5 Electrical wiring and control diagrams.
- .3 Test reports and certificates
  - .1 Certified shop test results of valves where specified.
- .4 Installation, operation and maintenance manuals
  - .1 Include material under this Section in Manual in accordance with Section 01300 and 01730.
- .5 Spare parts
  - .1 Submit spare parts list in accordance with Section 01300.

## 1.4 Quality Assurance

.1 The most current edition of the following standards is to apply to this contract:

ANSI B2.4	Standard Hose Coupling Screw Threads.
ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
ANSI B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
ANSI B16.10	Standard for Face-to-Face and End-to-End Dimensions of Ferrous Valves.
ANSI/ASME B1.20.1	General Purpose Pipe Threads (inch).
ANSI/ASME B31.1	Power Piping.
ASTM A 36	Specification for Structural Steel.
ASTM A 48	Specification for Gray Iron Castings.
ASTM A 126	Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
ASTM A 395	Specification for Ferritic Ductile Iron Pressure Retaining Castings for Use at Elevated Temperatures.
ASTM A 536	Specification for Ductile Iron Castings.
ASTM B 61	Specification for Steam or Valve Bronze Castings.
ASTM B 62	Specification for Composition Bronze or Ounce Metal Castings.
ASTM B98	Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
ASTM B 148	Specification for Aluminum-Bronze Castings.
ASTM B 274	Specification for Copper-Base Alloy Centrifugal Castings.
ASTM B 584	Specification for Copper Alloy Sand Castings for General Applications.
ASTM D 638	Test Method for Tensile Properties of Plastic.
ASTM D 1784	Specification for Polyvinyl Chloride (PVC) and CPVC Plastic Pipe Schedules 40, 80 and 120.
ASTM D 4101	Specification for Propylene Plastic Injection and Extrusion Materials.
ANSI/AWWA C500	Gate Valves for Water and Sewage Systems.
ANSI/AWWA C502	Dry-Barrel Fire Hydrants.
ANSI/AWWA C503	Wet-Barrel Fire Hydrants.
ANSI/AWWA C504	Standard for Rubber-Seated Butterfly Valves.
ANSI/AWWA C506	Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
ANSI/AWWA C507	Ball Valves 150 mm through 1200 mm.
AWWA C508	Swing-Check Valves for Waterworks Service, 50 mm through 600 mm.

- |  |                |   |
|--|----------------|---|
|  | ANSI/AWWA C509 | Standard Specification for Resilient-Seated Gate Valves for Water and Sewage Systems. |
|  | AWWA C550      | Protective Interior Coating for Valves and Hydrants.                                  |
|  | SSPC-SP-2      | Hand Tool Cleaning.   |
|  | SSPC-SP-5      | White Metal Blast Cleaning.   |
- .2 All other applicable standards used in the Municipal Infrastructure construction industry at the time of tender.
- 1.5 Field Quality Control**
- .1 Confirm face to face dimensions of valves and dimensions of valve operators with valve manufacturer.
- .2 Plumbing valves not included in valve schedule, confirm all valve schedules with drawings.
- 1.6 Product Delivery, Storage and Handling**
- .1 Deliver, store and handle valves and accessories in accordance with Section 15050.
- 1.7 Site Services of Manufacturer**
- .1 Arrange for manufacturer's representative to visit site to inspect, start-up, and field adjust:
- .1 Motorized valve actuators and valves.
- 1.8 Training**
- .1 Train Owner's staff in accordance with Section 01650 for:
- .1 Motorized valve actuators: minimum 4 hours on 2 separate days.
- 2.0 PRODUCTS**
- 2.1 General**
- .1 Provide valves of same type, size range, and service from single manufacturer.
- .2 Provide new, unused valves.
- .3 Provide valve materials free from defects or flaws with true alignment and bores.
- .4 Provide valves of same size as pipe run they are to be installed in, unless otherwise indicated.
- .5 Clearly mark valve bodies in raised lettering to indicate valve type, rating, and direction of flow. Conform to MSS SP-25. **Do not engrave valve numbers on bodies.** Numbering to use external tags applied after installation.
- .6 All other valves are to be supplied and installed by the Contractor unless otherwise specifically indicated.
- 2.2 Valve Actuators - General**
- .1 Motorized valves actuators (not applicable)
- .1 In accordance with Section 16 05 81.

- .2 Valve supplier to provide, and be responsible for, actuator, valve and controls.
- .3 Provide motorized actuated valves where indicated on Drawings and as specified in this section.
- .4 All motorized valves to have safety guards included, c/w safety locks.
- .5 Mount actuator on valve and test in shop.

**2.3 Manual Valves**

- .1 General
  - .1 Valve supplier to provide both valve and actuator.
- .2 Valve boxes
  - .1 Manufacturers: Canada Valve and Hydrants and BIBBY.
- .3 Levers
  - .1 Handle type with locking device, unless otherwise specified.
  - .2 Quarter turn lever operator's perpendicular to pipe when valve is closed.
  - .3 Ball valves: Two position lever operators.
  - .4 Butterfly valves: 10 position latching levers except where used to balance air flow. Infinite position screw down levers where used to balance air flow.
  - .5 Maximum pull at end of lever arm of 300 N where one side of valve is at test pressure and one side is at atmospheric pressure. Provide gear operator when greater than this force is required to operate valve with lever.
  - .6 Conform to following dimensions:

Nominal Valve Size (mm)	Minimum Length of Lever (mm)
6	80
12	80
20	100
40	150
50	150
65	150
80	175
100	225
150	250
200	300
250	450
300	450

- .4 Key operations
  - .1 In accordance with Section 15050.
  - .2 Fit the valves for key operation with 50 mm cast iron or ductile iron square operating nut.
- .5 Valve keys
  - .1 Valve keys: approximately 1000 mm long for valves with square operating nuts.
  - .2 Provide extensions where required to actuate valves.
- .6 Floor stands
  - .1 Neatly designed floor stands.

- .2 Valve position indication and handwheel as specified under this Section.
- .7 Manual gear operators
  - .1 Design: Gearing maximum force of 45 Nm required to unseat valve.
  - .2 Material: Hardened steel gears with bronze pinion shafts operating in bronze bearings.
  - .3 Type: worm gear equipped with handwheel and visual indicator of valve position.
  - .4 Adjustable mechanical stop-limiting device to prevent over travel of disc/ball in open and closed positions. Self-locking type designed to hold valve in any intermediate position between fully open and fully closed.
  - .5 Grease lubricated.
  - .6 Sealed with long life lubricant for submerged services.
  - .7 Gear ratios: minimum AWWA C-500, Table 7.
  - .8 Butterfly valve gearing: AWWA C-504, unless otherwise specified.
  - .9 Enclosed gear cases.

.8 Handwheel

- .1 Handwheel diameters conforming to:

Nominal Valve Size (mm)	Minimum Hand Wheel Diameter (mm)
12	50
20	50
25	60
40	75
50	85
65	105
80	200
100	250
150	300
200	350
250	400
300	450
350	450
400	550
450	600
500	600
600	600

- .2 Maximum rim pull on handwheel of 300 N when one side of valve is at test pressure and other side is at atmospheric pressure. Provide gear operator where shaft mounted handwheel requires greater than this force to operate.
- .3 Material: Cast Iron ASTM A-126 Class B or Ductile Iron ASTM A-536.
- .4 Type: spoked handwheel.
- .5 Direction of opening in raised letters cast on rim.
- .9 Extension stems and guides
  - .1 Material: Solid, tubular naval bronze, hardened Type 410 stainless steel, or Type 304 or 316 stainless steel.
  - .2 Guides: Cast iron with bronze or galvanized steel with Type 304 stainless steel bushings.

- .3 Bolts, nuts and washers: Type 316 stainless steel, designed to support extension stem.
  - .4 50 mm square operating nut on floor stand as specified.
  - .5 50 mm square operating nut in floor boxes with threaded cast iron covers and slotted, flush heads.
  - .6 Minimum 1000 mm long steel valve key for each valve type.
- .10 Torque tubes
- .1 Material: Schedule 80 heavy steel. Hot dip galvanize after fabrication.
  - .2 Ends: Flanged, 316 Stainless Steel.
  - .3 Install valve operator type as specified.
  - .4 Internal extension stem: Tubular or solid Type 304 or 316 stainless steel with bronze bushings to operator.
  - .5 Designs which allow for stagnant water to form are unacceptable.
  - .6 Provide stainless steel tag indicating maximum allowable torque.
- .11 Chain wheels
- .1 Chain operators are not necessarily shown on drawings.
  - .2 Provide chain operators for valves where valve centerline is minimum 2000 mm above finished floor elevation or platforms.
  - .3 Chain: Smooth welded link style of corrosion resistant material. Endless rust proof type chain terminating 1000 mm from finished floor.
  - .4 Install hooks at appropriate locations for chain tie-up.
  - .5 Chain wheel operators supplied by original valve manufacturer.
  - .6 Clamp-on style chain wheels with twisted-link chain are not acceptable.

## 2.4 Air-Vacuum and Air Release Valves

- .1 Air and Vacuum Valves: Air and vacuum valves shall be capable of venting large quantities of air while pipelines are being filled, and allowing air to re-enter while pipelines are being drained. They shall be of the size indicated, with flanged or screwed ends to match piping. Bodies shall be of high-strength material indicated in the specific data sheets. The float, seat, and moving parts shall be constructed of Type 316 stainless steel. Seat washers and gaskets shall be of a material insuring water tightness with a minimum of maintenance. Valves shall be designed for minimum 150 psi water-working pressure, unless otherwise indicated.
- .2 Air-Release Valves: Air-release valves shall vent accumulating air while system is in service under pressure and be of the size indicated. Valves shall meet the same general requirements as indicated for air and vacuum valves except that the vacuum feature will not be required. Valves shall be designed for a minimum water-working pressure of 150 psi, unless otherwise indicated.
- .3 Combination Air Valves: Combination air valves shall combine the characteristics of air and vacuum valves and air release valves by exhausting accumulated air in systems under pressure and releasing or re-admitting large quantities of air while a system is being filled or drained, respectively. Valves shall have the same general requirements as indicated for air and vacuum valves.
- .4 Sewage Air Release Valves: Sewage air release valves shall vent accumulating gases during system operation. Valves shall have long float stems and bodies to minimize clogging. The same general requirements shall apply as indicated for air and vacuum valves. Each sewage air release valve shall be furnished with the following backwash accessories, fully assembled on the valve:
  - .1 Inlet shut-off valve.
  - .2 Blow-off valve.
  - .3 Clear water inlet valve.
  - .4 Rubber supply hose.
  - .5 Quick disconnect couplings.

**2.5 Detailed Valve Specification Sheet: Air/Vacuum Release Valves**  
**Type ARV01**

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING			
			PRESSURE (kPa)	TEMP. (°C)		
Combination Air Valve with Surge Suppression	<b>ARV</b>	Liquid/Wastewater	1050	120		
TYPICAL SERVICE						
RAW SEWAGE						
VALVE MATERIALS			VALVE DESCRIPTION			
ITEM	MATERIAL		Reference Document			
Body	ASTM A351 Grade CF8M stainless steel		Size Range		25mm-100mm	
Orifice	Type 316 SS		Style		Refer to notes	
Float	Type 316 SS		Connections		Threaded	
Coating	Fusion Bonded Epoxy (inside and out) to NSF 61		Internal Parts		Type 316SS or better	
Orifice size and venting capacity	1/8" ; venting capacity 2% of maximum flow 120L/s in the pumping station		Additional Items		Refer to notes	
NOTES						
<ol style="list-style-type: none"> <li>.1 Supply and install all combination air valves, size and location, as shown on the drawings. Valves shall be specifically designed and manufactured for wastewater.</li> <li>.2 Valve shall be extended body, single chamber design.</li> <li>.3 The valve shall have a built-in anti-surge device with relief openings designed to automatically prevent the development of hydraulic transients during start-up and pressure surges.</li> <li>.4 Tag numbers and description/service on all valves.</li> <li>.5 Furnish with backwash accessories.</li> <li>.6 Resilient seats shall be Buna-N®.</li> <li>.7 Air valve bodies shall be coated with an exterior-grade, UV-resistant coating recommended by the manufacturer to resist dirt and grease marks during installation and maintenance.</li> <li>.8 The valve shall have a full port orifice, a double guided plug, and an adjustable threaded orifice button. The 1 in. (25 mm) body shall be globe style to increase float clearance and reduce clogging. The plug shall be protected against direct water impact by an internal baffle and an extended float stem. The plug shall have a precision orifice drilled through the center stem. The float shall include a sensitivity skirt to minimize spillage.</li> <li>.9 Valve designs employing hinges, levers, or ball type floats are specifically prohibited.</li> <li>.10 Valves shall be manufactured and tested in accordance with AWWA C512 and rated for maximum working pressures of 1034kPa (150 psi).</li> <li>.11 A Regulated Exhaust Device (RED) shall be provided and shall be mounted on the outlet of the Wastewater Combination Air Valve, allow free air flow in and out of the valve, close upon rapid air exhaust, and control the air exhaust rate to reduce pressure surges. The material of the body shall be consistent with the Wastewater Combination Air Valve.</li> </ol>						

ACCEPTABLE PRODUCTS			
Valmatic (801SS)(design basis)	Approved equal		

**Direct Buried Air Release Valve**

- .1 The Contractor shall supply and install an ARI air release valve model D-025 SB 32, 150psi (or approved equal) with a surface valve that can be buried below grade.
- .2 The Contractor shall provide a 200mm x 50mm saddle and tap at each of the high points along the forcemain. The piping from the forcemain to the offset location of the air release valve to enable the valve to be located inside the permanent easement. The contract form of tender does note two units and the drawings currently show only one unit. The second unit has been included in the event that some of the storm sewer crossing create an additional high point in the alignment. If the second unit is not installed it will be turned over as a spare unit to the operating authority.
- .3 The connection to the ARI valve shall be made to a 75mm blind flange on the bottom of the unit to the offset piping. Offset piping to be 50mm PEX pipe connected to a 50mm x 75mm MJ x FL 90 degree bend.
- .4 The unit shall be installed as per the manufacturer specification for an offset installation.
- .5 The air release valve shall be protected by installing a 300mm precast donut complete with standard manhole frame and cover as detailed on the contract drawings.

**2.6 Detailed Valve Specification Sheet: Ball Valves**  
**Type BLV01**

GENERAL					
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING		
			PRESSURE (kPa)	TEMP. (°C)	
Ball Valve	<b>BLV</b>	Liquid	1050	60	
TYPICAL SERVICE					
DRN					
VALVE MATERIALS			VALVE DESCRIPTION		
ITEM	MATERIAL		Reference Document		
Body	PVC Type I, Grade 1, Cell classification 12454-A, Min. 'A' designation for chemical resistance to ASTM D-1784.		Size Range		6mm to 100mm
Ball	PVC Type I, Grade 1, Cell classification 12454-A, Min. 'A' designation for chemical resistance to ASTM D-1784.		Style		PVC, Three Piece Factory Construction, Full Port.
Corner	PVC Type I, Grade 1, Cell classification 12454-A, Min. 'A' designation for chemical resistance to ASTM D-1784.		Valve Ends		Solvent Weld SCH 80PVC Socket Ends, ASTM D2467, Flanged ANSI B16.5 Class 150.
Stem	PVC Type I, Grade 1, Cell classification 12454-A, Min. 'A' designation for chemical resistance to ASTM D-1784.		Operator		Manual Levers.
Seat	Teflon PTFE.		Actuator		Note 1, Note 2.
Seals	EPDM		Additional Items		Note 3, Note 4, Note 5.
NOTES					
.1 Motorized: Provide motorized actuators for valves, where shown on drawings, in accordance with requirements of this Section 15100, (Clause 2.0, 2.2). .2 Refer to Division 16, Section 16 05 81. .3 Tag numbers and description/service on all valves. .4 Valves installed in the vertical position with flow upward. .5 Built in unions for valve assembly, seal carriers designed to be serviced in from both ends allowing valves to hold rated pressure in both directions when union not removed for maintenance, ball shall be vented for chlorine applications. .6 For Alum and Caustic service, valve ends shall be chemflare.					
ACCEPTABLE PRODUCTS					
Chemline, Series 21	Hayward		Praher		Series 54
Approved equal					

### Type BLV02

GENERAL					
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING		
			PRESSURE (kPa)	TEMP. (°C)	
Ball Valve	<b>BLV</b>	Liquid/Air	1050	40	
TYPICAL SERVICE					
<b>DRN, VENT VALVES, ARV, Instrument Isolation</b>					
VALVE MATERIALS			VALVE DESCRIPTION		
ITEM	MATERIAL		Reference Document		
Body	Type 316SS ASTM A-351, Grade CF8M.		Size Range		100mm and Smaller
Ball	Type 316SS ASTM A-351.		Style		Three Piece Ball Valve, Valve Rating ANSI Class 150.
Packing	Reinforced PTFE.		Valve Ends		Threaded ANSI B2.1.
Stem	Type 316SS ASTM A-351.		Operator		Note 1.
Seat	Reinforced PTFE (Durafill)		Additional Items		Note 2, Note 3, Note 4.
Pattern	Compact				
NOTES					
.1 Manual: Type 304SS lever handle with locking device. .2 Full port, grounded bottom loaded stem, blow-out proof stem, provide stainless steel plug on all vent valves. .3 Tag numbers and description/service on all valves. .4 Valves installed in the vertical position with flow upward.					
ACCEPTABLE PRODUCTS					
PMP A-301	Or Approved Equal				

**2.7 Detailed Valve Specification Sheet: Check Valves**  
**Type CHV02**

<b>GENERAL</b>					
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING		
			PRESSURE (kPa)	TEMP. (°C)	
End of Pipe	<b>DBV</b>	Liquid	1050	-	
<b>TYPICAL SERVICE</b>					
<b>RAW SEWAGE, DRN</b>					
<b>VALVE MATERIALS</b>			<b>VALVE DESCRIPTION</b>		
ITEM	MATERIAL		Reference Document		
Body	100% Elastomer (Neoprene).		Size Range		50mm to 900mm
Retaining Rings	304SS		Style		Curved Bill, Rating ANSI Class 125/150#.
Fasteners	304SS		Valve Ends		Flanged ANSI B16.1, Class 150.
			Additional Items		Note 1.
<b>NOTES</b>					
.1 Tag numbers and description/service on all valves.					
<b>ACCEPTABLE PRODUCTS</b>					
Tideflex/Red Valve	EVR Products (Base Design)		Cla-Val		

### Type SCV03

GENERAL					
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING		
			PRESSURE (kPa)	TEMP. (°C)	
Swing Check Valve	<b>SCV</b>	Liquid/Wastewater	1050	40	
TYPICAL SERVICE					
<b>RAW SEWAGE</b>					
VALVE MATERIALS			VALVE DESCRIPTION		
ITEM	MATERIAL		Reference Document		
Body	Ductile Iron ASTM A-536 or Cast Iron ASTM A-126, Class B.		Size Range		50mm to 1050mm
Cover	Ductile Iron ASTM A-536 or Cast Iron ASTM A-126, Class B.		Style		Swing Flex Check, AWWA C-508 with Spring Return.
Disc	Buna-N® w/Alloy Steel & Nylon Reinforcement, or EPDM.		Valve Ends		Cast Iron Flanged ANSI B16.1, Class 125.
			Additional Items		Note 1 to 6.
NOTES					
.1 Full flow body, domed access cover, full size access port for removal of disk, one piece disc construction. .2 Valve backflow actuator to be included (hold open device). .3 Valve to include surge protector, backflush device, and mechanical position indicator. .4 Tag numbers and description/service on all valves. .5 Valves installed in the vertical position with flow upward. .6 The seat and internal body shall be coated with a two-part liquid epoxy suitable for use in both potable water and wastewater applications.					
ACCEPTABLE PRODUCTS					
Pratt RD series		Approved Equal			

**2.8 Detailed Valve Specification Sheet: Gate valves**  
**Type GTV03**

<b>GENERAL</b>					
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING		
			PRESSURE (kPa)	TEMP. (°C)	
Gate Valve	<b>GTV</b>	Liquid	1725/80 to 300mm & 1380/350 to 600mm	40	
<b>TYPICAL SERVICE</b>					
<b>RAW SEWAGE</b>					
<b>VALVE MATERIALS</b>			<b>VALVE DESCRIPTION</b>		
ITEM	MATERIAL	Reference Document			
Body	Cast Iron ASTM A-126, Class B.	Size Range		80mm to 900mm	
Seat	Bronze	Style		AWWA C-509, fully guided solid wedge disc.	
Stem	Bronze	Valve Ends		Flanged ANSI B16.1, Class 125. Buried: restrained MJ.	
Extension Stems	Type 304SS, where required.	Operator		Note 2, Note 3.	
		Additional Items		Note 1, Note 4, Note 5.	
<b>NOTES</b>					
.1 Valves to close by turning stem in clockwise direction; c/w rising stem; positive backseat for re-packing under pressure. .2 Manual: enclosed gear operator with 300mm diameter cast iron handwheel. Conform to AWWA C-504, Class 25B. .3 Manual (buried): operating stem, sliding type valve box, provide extensions as required to operate valve with key provided. .4 Tag numbers and description/service on all valves. .5 Valves installed in the vertical position with flow upward. .6 Exposed gate valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator.					
<b>ACCEPTABLE PRODUCTS</b>					
AVK	Mueller	Clow	McAvity		

**2.9 Detailed Valve Specification Sheet: Knife Gate valves**  
**Type KNV01**

GENERAL						
TYPE OF VALVE	SYMBOL	TYPE OF COMMODITY	RATING			
			PRESSUR E (kPa)	TEMP. (°C)		
Knife Gate Valve	<b>KNV</b>	Liquid/Wastewater	1050	40		
TYPICAL SERVICE						
RAW SEWAGE						
VALVE MATERIALS			VALVE DESCRIPTION			
ITEM	MATERIAL		Reference Document			
Body	Cast 316SS, Grade CF8M c/w Packing Gland.		Size Range		100mm to 750mm	
Blade (Gate)	316SS Low-Friction Blade (Gate) with Rounded Edges.		Style		Wafer Type	
Seat	EPDM or Nitrile Material.		Valve Ends		Wafer Type Fully Lugged, Flanged ANSI B16.5, Class 150, TAPPI and MSS-SP-81, Face to Face dimension.	
Topworks	Note 1.		Operator		Note 3, Note 4.	
Packing	Note 2.		Actuator		Note 5.	
			Additional Items		Notes 6 and 7.	
NOTES						
<p>.1 Topworks: Stainless steel yoke and stem; aluminum-bronze or brass stem-nut; non-rising stem for motorized or gear operated valves; yoke pillars/beams to be of stainless steel or anodized aluminum with stainless steel tie rods; non-lubricated yoke bearings for ease of operation.</p> <p>.2 Packing: Braided, Teflon impregnated with resilient core; stainless steel packing gland with peripheral access to gland adjusting nuts; minimum of 4 gland bolts to ensure uniform packing load. CWP non-shock working pressure. Valve rating: drip tight shut-off for full pressure rating of 1050 kPa in either direction.</p> <p>.3 Valves shall be handwheel operated (with spinner knob on valves 16" and smaller). Provide other types of operation such as 2" square nut, chainwheels as required and/or specified. Bevel gear operated.</p> <p>.4 All manually operated knife gate valves shall be bidirectional, non-rising stem, manual and wheel operator. Extension stem and valve box shall be provided where indicated in the drawings.</p> <p>.5 Motorized: Provide motorized actuators for valves, where shown on drawings, in accordance with requirements of this Section 15100, (Clause 2.0, 2.2) and as noted below. All motorized knife gate valves to have safety guards include, c/w safety locks. Refer to Division 16, Section 16 05 81.</p> <p>.6 Tag numbers and description/service on all valves.</p> <p>.7 Exposed knife gate valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator.</p>						
ACCEPTABLE PRODUCTS						

.1 The Reviewed and Non-Reviewed Alternate Manufacturers will be reviewed after the award of the contract as per Section 01035 of this specification document. .2 The naming of a manufacturer in this specification is not an indication that the manufacturer's standard equipment is acceptable in lieu of the specified component features. Naming is only an indication that the manufacturer may have the capability of engineering and supplying a system as specified.			
Orbinox Series 22 (BT) (Base Design)	Dezurik	Stafsjo	Trueline

**2.10 Valve Assignments**

- .1 In addition to the above, the following table provides general information regarding valving assignments for this project, including general details for valves not previously noted but shown on drawings and required to be provided and installed by the Contractor.

Number	TYPE OF EQUIPMENT	VALVE TAG DRAWINGS	VALVE TYPE SPECS	DIAMETER (mm)	Description/Function
1	Air Valves	ARV-101	ARV01		
2	Ball Valves	BLV-101	BLV02	12	Pressure gauge isolation
3	Ball Valves	BLV-102	BLV02	50	Air valve isolation
4	Ball Valves	BLV-103	BLV02	80	Drainage
5	Ball Valve	BLV-104	BLV02	80	Drainage
6	Check Valves	CHV-101	SCV03	150	
7	Check Valves	CHV-102	SCV03	150	
8	Gate Valves	GTV-101	GTV03	150	
9	Knife Gate Valves	KNV-101	KNV01	150	
10	Knife Gate Valves	KNV-102	KNV01	150	
11	Knife Gate Valves	KNV-103	KNV01	150	
12	Knife Gate Valves	KNV-104	KNV01	150	
13	Knife Gate Valves	KNV-105	KNV01	150	
14	Knife Gate Valves	KNV-106	KNV01	150	
15	Knife Gate Valves	KNV-107	KNV01	150	
16	Odour Control Valve	NA	Wager Model 1800	100	Provide one for installation on wet well vent
17	Duckbill Valve	DBV-101	CHV02	80	Duckbill to prevent backup from wet well and mitigate gas migration

**2.11 Carbon Filter**

- .1 Flanged type activated carbon filters with additional permanganate media to be applied to each wet well vent for odour control.  
 .2 Approved Manufacturer: Robert H. Wager Co. Model 1800

### **3.0 EXECUTION**

#### **3.1 Preparation**

- .1 Valve and piping arrangement indicated in Drawings is based on typical dimensions for specified valves. Make modifications in piping to allow for discrepancies between dimensions where shown and those supplied for work.
- .2 Prior to installation of valves, field measure and check equipment locations, pipe alignments, and structural installation. Ensure that valve location and orientation provides suitable access to valve operators.
- .3 Inform Engineer and initiate necessary piping modifications at no cost to Owner, where conflicts are identified.

#### **3.2 Installation**

- .1 Install valves as indicated on Drawings, in accordance with Section 15050 and manufacturer's installation instructions.
- .2 Install valves at locations indicated on Drawings.
- .3 Install valves in conjunction with piping specified in Section 15060.
- .4 In horizontal pipe runs, mount valves with vertical operating shaft with actuator at top, unless otherwise indicated. (Not applicable for locations where space does not permit and for butterfly valves and trunnion ball valves.) Do not install valve with operator shaft pointing down, unless otherwise indicated in Contract Documents.
- .5 Unless otherwise specified, install single seated ball valves and knife gate valves with seat downstream. Install valves at tank connections with seat from tank. Install valves on pump discharge and suction lines with seat adjacent to pump.
- .6 Install gate valves in closed position.
- .7 Modify pipe dimensions to suit supplied valves, if face to face dimensions or other details are different from those shown on Drawings or specified.
- .8 Install butterfly valves in piping to provide sufficient room to access seat adjustment screws in removable section of piping.
- .9 Install valves with centreline of valve shaft where indicated on Drawings.
- .10 Install butterfly valves and trunnion ball valves with shaft in horizontal orientation.
- .11 Do not over torque bolts to correct for misalignment when joining valves to pipe or fittings.
- .12 Support valves in position using temporary supports until valves are fixed in place.
- .13 Install valves which are bubble tight in one direction to seal in direction opposite to normal flow unless otherwise noted or directed by Engineer.
- .14 Protect valves installed below grade with shrink sleeve or polyethylene sheath attached to pipe with tape wrap.
- .15 Install valves to provide sufficient access for operation, removal and maintenance and to prevent interferences between valve operators, structural members, equipment, walkways and hand railing and other similar items.
- .16 Adjust valve installation if there are interferences between valve or stem and surrounding area.
- .17 Do not route slings, chains, cables, or ropes through valve ports or attached to hand wheels to hoist valve in place.

- .18 Do not rest valves on operating shafts, hand wheels, actuators, cylinders or other parts prone to damage.
- .19 Install plug valves intended for throttling service to close to the upstream side.

### **3.3 Valve Extensions**

- .1 Install valve stem extensions where necessary to provide clearance from insulation.

### **3.4 Valve Leakage**

- .1 Shop test valves to AWWA standards, latest edition.

### **3.5 Field Tests**

- .1 Test valves and operators as integral component of piping system specified with Section 15050 and Section 15060.

**End of Section**

## 15190 Mechanical Identification Systems

### 1.0 General

#### 1.1 Summary

- .1 Section covers providing mechanical identifying devices for following:
  - .1 Manual valves.
  - .2 Control panels supplied under Division's 11, 15, and 16.
  - .3 Exposed piping systems.
  - .4 Buried piping systems supplied under Division 2.
  - .5 HVAC systems.
- .2 Conform to Section 15050 and Section 11000.
- .3 Comply with Division 1.
- .4 Provide labels for control panels, specified under Divisions 11 to 15 inclusive, in accordance with Division 16.

#### 1.2 Submittals

- .1 Shop drawings
  - .1 List of motorized and manual valves in tabular form indicating following for each valve:
    - .1 Valve number.
    - .2 Service.
    - .3 Valve type.
    - .4 Drawing No.
  - .2 Samples:
    - .1 Labels.
    - .2 Tags.

#### 1.3 Quality Assurance

- .1 CAN/CGSB-24.3-92 Identification of Piping Systems.
- .2 MOE Standard for Pipe Identification in Water and Wastewater Treatment Plants in Ontario, and Municipality standards.
- .3 Ministry of Labour Workplace Hazardous Material Information System (WHMIS) Policy.

## 2.0 PRODUCTS

### 2.1 Manufacturers

- .1 Type A labels
  - .1 Direct Labelling Services Limited.
  - .2 WH Brady of Canada.

- .2 Type B labels
  - .1 Direct Labelling Services Limited.
  - .2 WH Brady of Canada.
- .3 Valve labels
  - .1 Direct Labelling Services Limited.
  - .2 WH Brady of Canada.
- .4 Tank labels
  - .1 Direct Labelling Services Limited.
  - .2 WH Brady of Canada.
- .5 Buried pipe labels
  - .1 Direct Labelling Services Limited.
  - .2 WH Brady of Canada.

## 2.2 Pipe and Duct Exposed Labels

- .1 General
  - .1 Identify services by full name. Do not use abbreviations for labels.
  - .2 Colours: To MOE Standard for Pipe Identification in Water and Wastewater Treatment Plants in Ontario. See Table 15190-2.
- .2 General purpose services including insulated pipe (Type A)
  - .1 General:
    - .1 Material: self-sticking vinyl film.
    - .2 Type: permanently acrylic pressure sensitive adhesive of high tensile strength.
    - .3 Locations: Indoor and outdoor applications, non-aggressive, humid, corrosive.
    - .4 Apply labels to clean dry surface on pipes and ducts listed in Article 3.2.
    - .5 Ink: weather resistant.
    - .6 Service temperature: - 40°C to 82°C.
  - .2 Painted piping systems (pipes  $\leq$  25 mm):
    - .1 Label: 2 mil vinyl of sufficient length to wrap completely around pipe with minimum 8 mm overlap.
    - .2 PVC with self extinguishing flammable property.
    - .3 Label complete with permanent adhesive.
  - .3 Painted piping systems (pipes  $>$  25 mm):
    - .1 Label: 10 mil PVC sleeve with two-side permanent tape and liquid weld.
    - .2 PVC with self extinguishing flammable property.
    - .3 Sleeve: sufficient length to wrap completely around pipe with minimum 25 mm overlap.
- .3 Rough surfaces, [existing] service lines, and unpainted piping (Type B)
  - .1 General:
    - .1 Type: High performance PVC wrap-around marker permanently affixed to pipe surface.

- .2 Locations: indoor and/or outdoor applications, where specified.
- .3 Service: dusty, dirty, oily, or scaly pipe surfaces.
- .4 Environment: harsh.
- .5 Service temperature: -40°C to 120°C.
- .2 Unpainted piping systems (pipes ≤ 25 mm):
  - .1 Label: 2 mil vinyl of sufficient length to wrap completely around pipe with minimum 8 mm overlap.
  - .2 25 mm long labels complete with 12 mm colour banding at each end.
  - .3 One piece labels permanently fastened to pipe.
- .3 Unpainted piping systems (pipes > 25 mm):
  - .1 Label: 10 mil PVC sleeve, complete with two sided permanent tape and liquid weld.
  - .2 PVC with self extinguishing flammable property.
  - .3 Sleeve: sufficient length to wrap completely around pipe with minimum 25 mm overlap.
  - .4 500 mm long label with 100 mm color banding at each end.
- .4 One piece labels with 50 mm long tabs on pipes from 50 mm up to and including 100 mm in diameter.
- .4 Character sizes for labels

Table 15190-1:

ITEM	CHARACTER HEIGHT (mm)
Pipe O.D. <50 mm and smaller	12
Pipe O.D. 50 mm to <80 mm	20
Pipe O.D. 80 mm to <150 mm	30
Pipe O.D. 150 mm to < 250 mm	60
Pipe O.D. 250 mm and larger	90
Ducts	50

**2.3 Buried Pipe Labels**

- .1 Tape colours: To MOE Standard for Pipe Identification in Water and Wastewater Treatment Plants in Ontario or per Table 15190-2.
- .2 Tape description (general): "CAUTION - OIL OR GAS LINE BURIED BELOW".
- .3 Tape width: 150 mm.
- .4 Tape material: Heavy duty polyethylene resistant to acid, alkalis, and other soil substances.
- .5 Tape thickness: 3.5 mils.
- .6 Minimum tensile strength: 1,750 psi.
- .7 Identification of buried electrical conduits is provided under Division 16.

## **2.4 Manual Valve Tags**

- .1 Tags
  - .1 Material: Laminated 2-ply coloured plastic plate.
  - .2 Alpha-numeric characters shall be engraved, using Micarta lettering.
  - .3 1.6 mm thick and long enough to provide 19 mm clear of characters at each end.
  - .4 Valve tags with 2 holes, 3 mm in diameter at each end.
  - .5 Letter colours: by Engineer at later date.
  - .6 Valve tag sizing should be 40 mm x 40 mm.
  - .7 Use full name, do not use abbreviation, except as approved by Engineer.

## **2.5 Fasteners**

- .1 Valve tags: Use plastic type wrap.
- .2 Tanks: Adhesive as recommended by manufacturer suited for application and approved by Engineer.

## **2.6 Existing Identification System**

- .1 Use Owner's existing identification system where existing identification systems have been established.
- .2 Utilize Owner's existing identification system as far as possible and supplement with requirements of this Section where existing identification system is incomplete.
- .3 The intent is to identify mechanical systems specified under this Section to requirements of this Section.

## **3.0 EXECUTION**

### **3.1 Label Application - General**

- .1 Clean sufficient area of surface and apply label as recommended by label manufacturer.
- .2 Apply labels, directional arrows, and tags so that they are neat and uniform in appearance.
- .3 Apply labels, directional arrows, and tags so that they can be easily read from normal working locations.
- .4 Identify pipe that is electrically heat-traced with "ELECTRICALLY HEAT TRACED" lettering at specified locations.

### **3.2 Identification of Exposed Pipes and Ducts**

- .1 Identify following exposed piping and ducts according to the following table:

Table 15190-2:

Commodity	Pipe or Band Colouring	CGSB	Letter Colour	Label Background	Maximum Label Intervals (m)	Maximum Band Intervals (m)
<b>Group #1                      Flammable Materials</b> Propane Gas Natural Gas Hydraulic Oil Fuel Oil Digester Gas	Safety Orange	508-103	Black	Yellow	3	3
<b>Group #2                      Fire Fighting Protection</b> Standpipe System Sprinkler System Halon Fire Prot. Carbon Dioxide Fire Protection	Safety Red	509-101	White	Red	3	3
<b>Group #3                      Dangerous Substances</b> Boiler Feed Boiler Blow Off Acid Drain Compressed Air (Above 670 kPa) Ferric Chloride (High Temp Domestic Hot Water) LP Steam LP Condensate HP Steam LP Condensate	Safety Yellow	505-110	Black	Yellow	3	3
<b>Group #4                      Other Chemical Substances</b> Alum Solution Chlorine Solution Polymer Solution Lime Solution Sodium or Calcium Hypochlorite Solution Glycol Solution Heating Diesel Exhaust	White	513-101	Black	White	3	3
<b>Group #5                      Process Drainage</b> Raw Water Dom. Cold Water Sup. Dom. Hot Water Ret. Tempered Domestic Water Chilled Water Hot Water Heating Storm Drain Plumbing Vent Effluent Water Compressed Air Instrument Air	Dk. Blue Lt. Blue Lt. Blue Lt. Blue Lt. Blue Lt. Blue Lt. Blue Lt. Grey Lt. Grey Lt. Grey Lt. Grey Lt. Grey Lt. Green Lt. Green Lt. Green	502-103 502-106 502-106 502-106 502-106 502-106 501-108 501-108 501-108 501-108 501-108 501-108 501-108 501-108 501-108			6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	Not Req'd Not Req'd Not Req'd

Commodity	Pipe or Band Colouring	CGSB	Letter Colour	Label Background	Maximum Label Intervals (m)	Maximum Band Intervals (m)
Vacuum	Lt. Green	501-108	White	Green	6	Req'd Not
Nitrogen	Dk. Grey	501-103			6	Req'd Not
Sanitary Drain	Dk. Grey	501-103			6	Req'd Not
Filtrate (San.)	Mid-Brown	504-107			6	Req'd Not
Return Sludge	Mid-Brown	504-107			6	Req'd Not
Waste Sludge	Dk. Brown	504-102			6	Req'd Not
Raw Sludge	Dk. Brown	504-102			6	Req'd Not
Scum	Lt. Brown	505-206			6	Req'd
Supernatant						

**3.3 Application of Labels for Exposed Pipes and Ducts**

- .1 Apply identification label and directional arrows at or near following locations:
  - .1 Both sides of valves.
  - .2 Branch fittings and elbows.
  - .3 Both sides where pipes and ducts pass through walls, floors, and ceilings.
  - .4 Straight runs at maximum distance, centre to centre, as specified in table above.
  - .5 Where circumstances make contents or direction of flow doubtful.
- .2 Apply labels in positions that allow them to be easily read from normal operation positions.
- .3 Apply labels in workmanlike manner.

**3.4 Identification of Buried Pipe**

- .1 Provide caution tape for buried pipe for services identified in the following table:

Table 15190-3:

ABBREVIATION	COMMODITY
NG	Natural Gas
LP	Liquified Propane Gas

- .2 Locate caution tape 600 mm above top of pipe.

**3.5 Identification of Motorized and Manual Valves**

- .1 Label manual and motorized valves where valves are shown with tag numbers on Process and Instrumentation Drawings.
- .2 Label manual valves 25 mm in diameter and larger.
- .3 Label motorized valves.
- .4 Do not engrave valve numbers on bodies. Numbering to use external tags applied after installation.

**End of Section**

## 15400 Plumbing and Drainage

### 1.0 General

#### 1.1 Scope of Work

- .1 The work required under this Section of the Specifications shall include all labour, equipment and materials to complete all plumbing and drainage work as indicated on the drawings and specified herein including the following briefly described: (Not all inclusive)
- .2 Sanitary drainage system shall include all exposed (within chamber and wet well) and below ground piping, equipment and accessories specified herein or shown on the drawings for a complete system.

#### 1.2 Codes, Approvals and Permits

- .1 Perform the entire installation in accordance with the latest codes and regulations as specified herein.
- .2 All equipment installed must be approved by the Canadian Standards Association, Underwriter's Laboratories of Canada where applicable and other approval agencies.
- .3 Conform to the applicable codes and regulations of the Office of the Fire Marshal (Ministry of the Attorney General), ULC, CSA and CGA associations, and all other Provincial and local municipal regulations.

#### 1.3 Submittals

- .1 Submit shop drawings, manuals, parts lists to the Engineer for review and approval as set out in Section 01330.

#### 1.4 Related Work Specified Elsewhere

- .1 Section 15250: Mechanical Insulation.

#### 1.5 Materials

- .1 All materials shall be new, and acceptable by the latest Ontario Building Code Act unless otherwise noted, of first quality, subject to the approval of the Engineer. To avoid delay in the work, materials must be ordered as soon as Contract is awarded. Report at once to the Engineer any delay in delivery that would retard completion of the work.

#### 1.6 General Requirements

- .1 Furnish and install all piping systems in accordance with applicable requirements of specifications.

## 2.0 PRODUCTS

### 2.1 Piping Materials - Underground

- .1 Drain:
  - .1 PVC Schedule 40 pipe with transition to stainless steel into wet well, as shown on drawings.

## **2.2 Piping Materials – Above Ground (Valve Chamber)**

- .1 Drain:
  - .1 PVC Schedule 40 pipe and fittings for DWV use conforming to CSA Standard CAN3-B181.1-M85 with solvent cemented fittings.
- .2 Ball Valves:
  - .1 Refer to valve specifications.
- .3 Check Valves:
  - .1 Refer to Section 15060, Process Piping & Valves.
- .4 Flexible Connectors:
  - .1 Services: Sanitary sewer.
  - .2 Type: Flexible coupling.
  - .3 Materials: Elastomeric polyvinyl chloride.
  - .4 Pressure rating: 29.6 kPa.
  - .5 Maximum Operating Temperature: 140°F.
  - .6 Manufacturers: Fernco Joint Sealer Company, or approved equal.
- .5 P - Traps
  - .1 Provide and install PVC "P" trap on floor drain discharge.

## **3.0 EXECUTION**

### **3.1 Pipe Installation**

- .1 Underground:
  - .1 Establish and layout all lines as indicated.
  - .2 Slope all straight runs to a minimum of 2.0% or as otherwise specified.
  - .3 Use Surveyor's optical level or other approved means to determine all grades and inverts.
  - .4 Excavation, bedding and backfilling to be in accordance with Section 02200: Earthwork.
  - .5 Bedding and backfill to be Granular 'A' to OPSS 1010 place in 200 mm maximum lifts compacted to 98% of Standard Proctor maximum dry density unless under pavement where 100% compaction required.

### **3.2 Character of Pipe Work**

- .1 In general, lay the pipe in the location as shown on the plans. No work shall be altered unless layout has been approved by Engineer with whom this Contractor shall take up the proposed layout of all plumbing lines not shown on the plans and get approval of their erection before proceeding.
- .2 All horizontal soil and waste lines shall have uniform drop of not less than 6 mm per 300 mm (1/4" per foot) except where conditions will permit, 3 mm per 300 mm (1/8" per foot) will be accepted if approved by local code.

**End of Section**

**DIVISION 16  
EQUIPMENT**

## **Division 16 Electrical - Index**

*16000 Common Work for Electrical*  
*16030 Commissioning of Electrical Systems*  
*16110 Raceways and Boxes*  
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*16160 Grounding and Bonding*  
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*16900 Process and Building Instrumentation*  
*16902 Power Metering and Instruments*  
*16920 PLC & SCADA Control and Integration*

**End of Section**

## 16000 Common Work for Electrical

### 1.0 General

#### 1.1 Scope of Work

- .1 The following is a general, but not necessarily complete, description of the electrical work and services to be provided under this contract. All the products and services mentioned or shown in the documents shall be provided, including all the incidentals necessary for a complete and working electrical system to the satisfaction of the Engineer.
  - .1 Electrical distribution in an outdoor enclosure, including service entrance equipment, distribution transformers, distribution / lighting panelboards and auxiliaries, field disconnect switches and control stations/panels, including power, control and communication cables, wireways and terminations, complete with supports, stands and mounting hardware.
  - .2 Standby generation, including natural gas generator, automatic transfer switch, controllers, field wiring and auxiliaries.
  - .3 Instrumentation, including instruments, field wiring, control panels and auxiliaries.
  - .4 SCADA, including installation of RPU/PLC panels, communication panels, and PLC/SCADA hardware, including start-up and commissioning support, and complete field wiring.
- .2 The following items are part of the cash allowance:
  - .1 Hydro One Electrical Service.
  - .2 SCADA Integrator: PLC and OIT programming, start-up and commissioning.

#### 1.2 Related Sections

- .1 This section covers items common to all sections of Electrical Division, and includes specifications for products, criteria and characteristics, methods and execution that are common to one or more sections of the Specification, and it is intended as a supplement to each section and is to be read accordingly.
- .2 This section and all sections of the Electrical Division are intended to supplement the General Requirements Division, all other Divisions of the Specifications, and all of their subsections.
- .3 This section and all sections of the Contract Specifications apply to and are a part of the Contract Documents and are to be read accordingly.

#### 1.3 References, Codes and Standards

- .1 All components and assemblies shall be designed, manufactured, installed and tested in accordance with the latest applicable CSA, UL/cUL/ULC, NEMA, ANSI, and/or IEEE standards.
- .2 Electrical works specified under the Electrical Division shall comply to the following collection of standards:
  - .1 CSA C22.1 Canadian Electrical Code Part 1 - Safety Standard for Electrical Installation, including Ontario Amendments (Ontario Electrical Safety Code - OESC)

- .2 CSA C22.2 Canadian Electrical Code Part 2 – General Requirements
  - .3 CSA C22.3 Canada Electrical Code Part 3 - Electricity Distribution and Transmission
  - .4 CSA C22.3 No. 61936-1 - Power installations exceeding 1 kVac - Part 1: Common Rules
- .3 Where any code, regulation, by-law or standard is quoted it means, unless otherwise specifically noted, the current edition including all revisions and amendments at the time of the Contract.
- .4 Where regulatory codes, standards and regulations are at variance with the Contract Documents, the more stringent requirement shall apply.

#### **1.4 Permits, Fees and Inspection**

- .1 The Contractor shall submit for, obtain and pay for all permits required to complete Work in accordance with Division 1.
- .2 The Engineer shall submit to the Plan Approval Department of the Electrical Safety Authority the required number of drawings and specifications for plan approval prior to commencement of Work.
- .3 The Contractor shall provide documents, specification and drawings as required to the Electrical Inspection Department, the Supply Authority and the Building department as required.
- .4 The Contractor shall notify the Engineer of changes required by the Electrical Inspection Department prior to making changes.
- .5 Include in each copy of operating and maintenance instruction manuals, copies of inspection certificates issued by regulatory authorities to certify that the completed Work is in accordance with the regulations of the regulatory authorities and is acceptable to them.

#### **1.5 Electrical Contractor Qualifications**

- .1 Work is to be carried out by a Contractor who holds a valid contractor license for each respective trade.
- .2 The site foreman for each respective trade must be a registered master journeyman.
- .3 All work is to be carried out by qualified, licensed trade persons in their particular disciplines as in accordance with the conditions of the governing requirements respecting manpower vocational training and qualification. Employees registered in certified apprentice programs shall be permitted, under the direct supervision of qualified licensed trade persons in that discipline, to perform specific tasks.
- .4 Specialist Contractors shall have received specific training by the applicable manufacturer for the products being provided.
- .5 All trade people are to provide proof of qualification upon request by the Engineer. Failure to do so might result in removal of that individual from the site, without compensation.
- .6 Submit its company's policies and procedures for confined space entry, hot work, and live work; follow Owner's or own procedures whichever is more stringent.
- .7 The Contractor shall follow Owners standard lock-out/tag-out procedures. Padlocks shall be supplied by the Contractor.
- .8 Controls and Instrumentation Subcontractor

- .1 The Subcontractor shall be approved by the Engineer prior to project commencement.
- .2 The Subcontractor shall have experience in the installation of the process instrumentation, field communication networks and programmable logic controllers, with demonstrated experience on similar applications (e.g. water and wastewater treatment plants).
- .3 The Subcontractor shall provide qualified personnel to install equipment, assist in commissioning and testing of systems to the satisfaction of the Engineer.

#### **1.6 Equipment Manufacturer Qualifications**

- .1 The Manufacturer of the assembly shall be the manufacturer, or an OEM company certified by the Manufacturer, of the components used within the assembly.
- .2 The Manufacturer shall be CSA certified in accordance with CAN/CSA-Q9000-2.
- .3 The manufacturer shall be approved and registered with the International Standards Organization in the applicable ISO 9000, ISO14000 or ISO product manufacturing category.
- .4 The specified/acceptable Manufacturer requesting approval to substitute a new product line and Manufacturer of an alternate shall have produced similar electrical equipment with a sufficient installation base for a minimum period of five (5) years. When requested by the Engineer an acceptable list of installations (installation base) with similar equipment shall be provided demonstrating compliance with this requirement.
- .5 The Manufacturer of the new product or alternate without the sufficient installation base for the above stipulated time period shall:
  - .1 Provide in addition to the standard warranty, the extended warranty and technical support for minimum of five (5) years without increase in the equipment price and without additional incremental cost to the Owner.
  - .2 Provide access to the Engineer of the standard installation, functional and operational drawings for the complete assembly, sub-assemblies and components, as well as the copies of the required regulatory certificates and test results.
  - .3 When requested by the Engineer, the Manufacturer shall arrange a visit to the manufacturing and design facilities for inspection and verification. The Manufacturer shall be responsible for transportation, meals, lodging and incidental cost for up to two (2) Engineer's representatives for an agreed duration.

#### **1.7 Specified, Acceptable and Alternative Manufacturers, Equipment and Materials**

- .1 Specified, acceptable and alternative manufacturers, equipment and materials are to be in accordance with Division 1.
- .2 Naming a specific manufacturer, equipment or material does not imply acceptance of their standard products nor relieve them from meeting these specifications in their entirety.
- .3 Materials and equipment scheduled and/or specified in the Contract Documents 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 material or equipment specified by manufacturer's name and model number. The Schedule of Prices may be based on materials and equipment supplied by any of the manufacturers named as acceptable for the particular material or equipment. If acceptable manufacturers are not stated for a particular material or equipment, base the Schedule of Prices on material or equipment supplied by the specified manufacturers.

- .4 If materials or equipment supplied by a manufacturer named as acceptable are used in lieu of the manufacturer specified, the bidder shall be responsible for ensuring that the substituted material or equipment is equivalent in performance and operating characteristics to the specified materials or equipment, and, that any additional costs and changes to associated or adjacent work resulting from provision of materials supplied by a manufacturer other than the specified manufacturer is included in the Schedule of Prices. In addition, in equipment locations where equipment named as acceptable is used in lieu of specified equipment and the dimensions of such equipment differs from the specified equipment, prepare and submit for review accurately dimensioned layouts for the locations affected.
- .5 In addition to the manufacturers specified or named as acceptable, alternative manufacturers of materials or equipment may be proposed to the Engineer for acceptance. Prior to submittal of shop drawings, provide list of products proposed, including any alternatives submitted with the tender. To receive acceptance, proposed alternates are to equal or exceed the quality, finish and performance of those specified and/or shown, and not to exceed the physical space requirements allotted, as shown on the drawings. Provide to the Engineer documented proof of equality, difference in price (if any) and delivery dates, in the form of certified quotations from suppliers of both specified items and proposed substitutions. Include engineering and material costs for any required revisions to other structures and products to accommodate such substitutions.

## **1.8 Warranty**

- .1 Warranty requirements are to be in accordance with Division 1.
- .2 The Contractor shall warrant the installation and equipment in strict accordance with the Contract Documents and free from all defects in materials and workmanship for a period of one (1) year minimum from the date of an acceptance of the commissioning report, unless otherwise stated in the specific sections.
- .3 The Manufacturer shall warrant the equipment in strict accordance with the Contract Documents and free from all defects in materials and assemblies for a period of two (2) years minimum from the date of an acceptance of the commissioning report, unless otherwise stated in the specific sections.
- .4 Indicate any no-charge extended warranty including the conditions of such warranty.
- .5 The Manufacturer or manufacturer's certified technical representative, and the Contractor, as required, shall repair and/or replace any defects that appear in equipment and assemblies within the warranty period, due to the ordinary wear and tear, and expected environmental agents, without additional expense or deductibles to the Owner, such as travel time, service hours, repair parts cost, etc. Where such defects occur, be responsible for all costs incurred in making the defective equipment and assemblies good, including repair or replacement of building finishes, other materials, or damage to other equipment caused by such defects, or by subsequent replacement and repairs.
- .6 After commissioning and start-up but prior to applying for final payment or release of statutory holdback, the Contractor and Manufacturer shall provide two separate cross-referenced letters of warranty and guarantee signed and issued in the name of the Owner stating that complete assembly including all accessories is guaranteed against defects and malfunction for the specified warranty period.

## **1.9 Shop Drawings and Product Data**

- .1 Provide shop drawings and product data sheet in accordance with the requirements of Division 1.

- .2 The terms "shop drawing" or "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided to illustrate details of a portion of Work.
- .3 Submit shop drawings as indicated in individual specification sections.
  - .1 Indicate materials, methods of construction and attachments or anchorages, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
  - .2 Accompany submissions with a transmittal letter, containing: date, project title and number, Manufacturer's/Contractor's name and address, identification and quantity of each shop drawing, product data and sample, and other pertinent data.
  - .3 Endorse each shop drawing copy to be in accordance with specification and contract documents, including your company name, the submittal date, and signature. Shop drawings that are received and are not endorsed, dated and signed will be returned for re-submittal.
  - .4 Submit product data and shop drawings in AutoCAD DWF and/or PDF format. Scanned PDFs shall not be accepted.
  - .5 Submit an electronic copy in non-scanned PDF format of product data sheets where shop drawings will not be prepared due to standardized manufacture of product. Supplement standard information to provide details applicable to this project and delete information not applicable to this project for clarity and ease of reading.
- .4 Allow fifteen (15) days for Engineer's review of each submission. The Engineer will review shop drawings and will indicate his review status by stamping shop drawing copies.
  - .1 "Reviewed" or "Reviewed as Noted" - If the Engineer's review of a shop drawing is final, the Engineer will stamp the shop drawing "Reviewed" or "Reviewed as Noted" (appropriately marked). After which fabrication and installation of Work may proceed.
  - .2 "Revise and Resubmit" - If the Engineer's review of a shop drawing is not final, the Engineer will stamp the shop drawing "Revise and Resubmit", mark the submission with comments, and return the submission. Revise the shop drawing in accordance with the Engineer's notations and resubmit.
  - .3 It is understood that the following is to be read in conjunction with the wording on the Engineer's shop drawing review stamp applied: "This review by the Engineer is for the sole purpose of ascertaining conformance with the general design concept. This review shall not mean that the Engineer approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of their responsibility for errors or omissions in the shop drawings or their responsibility for meeting all requirements of the Contract Documents. The Contractor is 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 co-ordination of Work of all subtrades".
- .5 Make changes in shop drawings as the Engineer may require, consistent with Contract Documents. When resubmitting, notify the Engineer in writing of any revisions.
- .6 Adjustments made on shop drawings by the Engineer are not intended to change the Contract Price. If adjustments affect value of Work, state such in writing to the Engineer prior to proceeding with Work.

- .7 If upon review by the Engineer, no errors or omissions are discovered or if only minor corrections are needed, one (1) copy in DWF, PDF format or hard copy will be returned. The Contractor is responsible for distribution of the required numbers of copies, after which fabrication and installation of Work may proceed.
- .8 Submissions shall include, but not be limited to, the details as applicable:
  - .1 Performance characteristics;
  - .2 Standards;
  - .3 Technical data sheet;
  - .4 Fabrication details;
  - .5 Layout, elevation and plans, showing dimensions, including identified field dimensions and clearances;
  - .6 Physical capacities and operating weight;
  - .7 Relationship to adjacent work, where applicable;
  - .8 Setting or erection details, where applicable;
  - .9 Single line, winding configuration, wiring and schematic diagrams, including polarities and phase rotation;
  - .10 Component schedules, including circuit breakers, disconnect/loadbreak switches, fuses, relays, trip-units, solenoids, switches, pushbuttons, timers, etc.
  - .11 Control schematic for each generator, transfer switch, circuit breaker and load controlled by the combination starter, VFD, RVSS, etc., including all interlocks and local or field power, control and indication devices.
  - .12 Nameplate schedule;
  - .13 Ratings including: voltage, BIL, continuous current, short-circuit / interrupting ratings, insulation class and temperature rise, etc.
  - .14 Specific test data, and where applicable including: no-load and full-load losses, excitation and starting current, design impedance at rated temperature rise, efficiencies at 25%, 50%, 75% and 100% load, regulation at 80% and 100% load power factor, audible sound level, etc.
  - .15 Dimensioned cable/busway entry and exit locations, including cable lug sizes;
  - .16 Dimensioned cable terminations;
  - .17 Dimensioned position and size of bus bars and extension details;
  - .18 Connection details and composite floor plan of close-coupled assemblies;
  - .19 Key interlock schemes diagram and sequence of operations;
  - .20 Time-current characteristics of protective devices, including breakers, fuses overload relays, etc.

#### **1.10 Operation and Maintenance Manuals**

- .1 Provide operation and maintenance manuals in accordance with the requirements of Division 1.
- .2 Provide operation and maintenance manual in English to include equipment as indicated in individual specification sections.
  - .1 Provide one (1) electronic copy for review that will be returned after final inspection, with Engineer's comments.
  - .2 Two weeks prior to Substantial Performance of Work, submit to the Engineer, six (6) final copies of operating and maintenance instruction manuals. Include within each binder the final electronic copy on USB drives.

- .3 Include details of design elements, construction features, component function and maintenance requirements, to permit effective start-up, operation, maintenance, repair, modification, extension and expansion of any portion or feature of installation shall form part of the binder.
- .4 Include manufacturer's printed operation and maintenance instructions.
  - .1 Include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
  - .2 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions; and any special operating instructions.
  - .3 Maintenance Requirements: include routine procedures and guide for troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
  - .4 Provide parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .5 Include as-built single-line diagrams, power and controls wiring and schematic diagrams.
- .6 Include as-built shop drawings, with revisions noted for shop drawing review, manufacturing, installation and commissioning, where applicable.
- .7 Include power system analysis report.
- .8 Include commissioning report.
- .9 Include manufacturer's certification sign-off letter.
- .10 Include all ESA inspection certificates. Include a copy of the ESA Plan Review report where applicable.
- .11 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .12 Substantial Performance may not be granted without above submittals being received and approved by the Engineer.

#### **1.11 As-built Drawings**

- .1 Prepare complete set of as-built drawings field redline mark-ups, shop drawing data, and change order modifications.
- .2 Provide as-built single line diagram on 10mm stiff board, minimum ANSI D size, with a matte laminated protective finish. The board is to be mounted within the plant electrical room and/or in a prominent location chosen by the Owner and Engineer.

#### **1.12 Spare Parts, Maintenance Materials and Special Tools**

- .1 Provide spare parts, maintenance materials and special tools in accordance with the requirements of the Division 1.

## **2.0 Products**

### **2.1 Summary of Ratings & Characteristics**

- .1 The quantity and ratings, including system operating voltage, current rating, and short-circuit rating shall be as indicated on the drawings, specification and schedules.
- .2 To assure a fully selective system, all components that are part of an assembly, including panelboards, combination contactors, starters, VFDs that are part of an assembly, shall have combination short-circuit rating certified by the assembly manufacturer. The equipment without the short-circuit rating on the CSA/cUL nameplate, or ESA special inspection nameplate, or the equipment without certified test records, will not be accepted.

### **2.2 Materials and Equipment**

- .1 Provide all materials and equipment including incidentals necessary for a complete and working system to the satisfaction of the Engineer.
- .2 Provide equipment of a certain type from one manufacturer for entire project.
- .3 Equipment, materials, components and assemblies to be CSA/cUL approved/certified. Where there is no alternative to supplying assemblies with CSA/cUL approved/certified, obtain special field approval from CSA/cUL or ESA Special Inspection.
- .4 Unless otherwise specified, all materials and apparatus for permanent installations are to be new. All expressly permitted used material and equipment shall be tested and certified prior to use.
- .5 Assemble in factory all control panels and component assemblies.

### **2.3 Enclosure**

- .1 Provide enclosures in accordance with:
  - .1 CSA C22.2 No. 94.1 / UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
  - .2 CSA C22.2 No. 94.2 / UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
- .2 Each enclosure shall be properly sized to dissipate the heat generated by the equipment within the limits of the specified environmental operating conditions.
- .3 The steel structure shall be welded steel frame, formed steel doors and side sheets, flat steel top and rear covers, and provision for lifting.
- .4 The enclosures of the assemblies and subassemblies metal surfaces shall be given a phosphatizing pre-treatment after machining and prior to assembly.
- .5 The paint coating shall be a polyester urethane, thermosetting powder minimum of 2-mil thickness, applied by electrostatic means, and unless specified otherwise, exterior shall be painted to the standard manufacturer's colour; enclosures interior shall be painted white.
- .6 Unless specified otherwise, enclosure shall have full height hinged door(s) with key-lockable handle.
- .7 The equipment shall be pre-wired and factory assembled.
  - .1 Unless required otherwise, all components shall be dead front with the door open.
  - .2 Components requiring system level voltage shall not be mounted on the door, unless specifically approved for the used by the component or assembly standard.

- .8 Enclosure shall be provided with adequate removable lifting means and shall be capable of being rolled or lifted into installation position and bolted to the floor and/or wall.
- .9 Outdoor enclosures shall have thermostatically controlled heaters in each section.

## 2.4 Wiring and Terminations

- .1 Provide wiring and terminations in accordance with Section 16120 Wires and Cables.
- .2 All wiring and terminations shall be CSA/UL approved.
- .3 Provide all small wiring, necessary fuse blocks and terminal blocks within the assemblies and free standing / wall mount enclosures as required.
- .4 A termination system within assemblies shall be provided such that no additional cable bracing is required to maintain the short circuit withstand ratings of the assembly.
- .5 Provide XLPE, RW90, 600/1000V rated insulation power wiring, copper conductors, extra-flexible where required, size to suit ampacity as required.
- .6 Provide XLPE type SIS 90°C or TEW 105°C, 600V rated control wiring with flexible, stranded, tin-plated copper conductors, supported and neatly bundled.
  - .1 Unless specified otherwise, provide 14AWG red AC and blue DC control wiring, 12AWG grey or black VT and CT wiring.
- .7 Where required, enclosures, cable entrance, or cable compartment(s) shall be provided with a non-magnetic, non-metallic plate for single-phase cable entry.
- .8 Cable compartment(s) cell shall have adequate space dedicated for the type and size of wiring used.
- .9 Where cable terminates on the bus bars or equipment without lugs, provide NEMA 2-hole mechanical lugs with anti-turn feature, suitable for copper or aluminum cable rated for 90°C of the size as indicated on the drawings.
- .10 Provide NEMA 1-hole mechanical lugs with anti-turning feature for termination grounding/bonding conductors.
- .11 Where indicated on the drawings, provide test switch for termination of the instrumentation CT and VT wiring on an assembly control compartment door. Each test switch to be multi-pole design c/w cover, test plug, and with required number of shorting and isolation poles.
- .12 Insulated crimp ring lugs shall be provided on the control wire terminating on meters, relays, test switches, CTs, VTs and CPTs.
- .13 Each metering, relay or auxiliary control compartment shall be furnished with suitable readily accessible terminal blocks for control wire terminations, DIN rail mounted.
  - .1 The following types of terminal blocks shall be provided:
    - .1 Shorting terminal blocks for secondary connection of CTs;
    - .2 Terminal blocks for secondary VT connections, fusible for main, non-fusible for others;
    - .3 Control terminal blocks, fusible or non-fusible;
    - .4 Field wiring terminal blocks.
  - .2 Arrange terminal blocks in logical manner for grouping of similar signals. Signals requiring multiple terminals shall be grouped together forming potential distribution using suitable manufacturer's cross-connectors. Provide partition plates between set of the terminal connections designated for each control voltage and type of the controls.

- .3 For all terminal blocks provide original manufacturer's plastic marking tags, pre-printed, black text on white background.

## **2.5 Equipment Identification and Warning Labels**

- .1 Provide equipment manufacturer nameplates and warning labels in accordance with CSA/UL requirements and as required by the local authority having jurisdiction.
- .2 Provide manufacturer's identification nameplates for the control identification tags (e.g. HAND, START, RUN etc.). Unless otherwise specified, lamacoid to be white text on black background.
- .3 Provide manufacturer's identification and custom enclosure identification nameplates, lamacoid with black text on white background. Include distribution centres (one per each vertical section), distribution centre components (e.g. breaker, starter, etc.), control power panels, control panels, control stations, disconnects, etc. Alternatively, when approved by the Engineer, provide thermal transfer laser printed labels for smaller equipment such as control stations and disconnects. Minimum sizes as follow:
  - .1 Distribution centre, single-line: 75mm x 175mm, text 50mm (single-line).
  - .2 Control/power panel: 50mm x 125mm, text 25mm (single-line) or 15mm (multi-line).
  - .3 Individual starter, breaker, control station, etc.: 25mm x 63mm, text 3mm (multi-line).
- .4 Wording on nameplates and labels to be approved by Engineer prior to manufacture. Include equipment tag, supply voltage, power source and signal destination.
- .5 Identification to be in English.

## **2.6 Hardware, Hangers and Support**

- .1 One-hole malleable iron, aluminum or steel straps with nylon spacers to secure surface cables/conduits having diameter 25 mm and smaller; two-hole straps for cables/conduit larger than 25 mm; aluminum straps for single conductor cables.
- .2 Stainless steel or aluminum hardware for corrosive atmosphere.
- .3 Channel type supports for two or more cables/conduits and cable tray in accordance with Code requirements.
- .4 Cable-to-channel and/or cable-to-tray clamps, size and material to suit application, aluminum, steel or stainless steel, with suitable saddle to suit installation.
- .5 U shape strut, galvanized steel and/or aluminum, as indicated in the drawings, minimum size 41 x 41mm, 2.5 mm thick.
- .6 Threaded rods, imperial size, minimum 12.7 mm (1/2") dia, to support suspended channels c/w spring clips.
- .7 Beam clamps to secure conduit to exposed steel work.
- .8 Cable ties, size and material to suit application. Weather resistant Nylon 12 or polypropylene for application in corrosive environment; Nylon 6 is not acceptable.

## **3.0 Execution**

### **3.1 Planning and Coordination of Services or Installations**

- .1 The Contractor shall visit the site before submitting his tender and shall by personal examination satisfy himself as to the local conditions that may be encountered during

construction of Work. The Contractor shall make his own estimate of the facilities and difficulties that may be encountered and the nature of the subsurface condition, building construction, finishes and work associated with the electrical work in order that the tender price includes for everything necessary for completion of the electrical work.

- .2 The 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 show architectural and structural details. The locations of materials and equipment may be altered to meet requirements of the material and/or equipment.
- .3 The Contractor is to plan exact locations and routing of the services and these are to be properly co-ordinated, optimized, and established with all affected Owner processes and other trades prior to installation such that the services will clear each other as well as any obstructions. Generally, give the right of way to civil, structural, process, mechanical and architectural works, locate and arrange electrical, control and instrumentation services to suit.
- .4 The drawings, specifications and schedules are intended to be co-operative. Perform all work that is shown, specified or reasonably implied on the drawings but not mentioned in the other documents, and vice versa, as though fully covered by each.
- .5 The Contractor shall examine the drawings and specifications of all divisions and become fully familiar with Work. Before commencing work, obtain a ruling from the Engineer on any conflicting issues between divisions. No compensation will be made for any costs arising from conflict not identified before work has commenced.
- .6 The Contractor shall prepare detailed installation and interference drawings, together with instructions, supplementary to the Contract Drawings, for all areas where a multiplicity of services and/or equipment occurs, or where Work, due to architectural, physical, structural or other considerations, is complex or involves special study or treatment. Provide detailed drawings to the Engineer in shop drawing form for review before the affected work is installed. Work that has been installed without proper co-ordination, study, and review, even if in accordance with the Contract Documents, shall be carried out without additional cost. In addition, make any alterations necessary in other work required by such alterations, without additional cost.
- .7 The Contractor is to be responsible for the care of all existing equipment and services and shall repair or replace any damage whatsoever caused by the installation or workers of Work under this contract at the contractor's cost. All repairs and or replacements are to be approved by the Engineer and accepted by the City prior to installation.
- .8 Where new work connects with existing work and where existing work is altered, cut, patch and make good to match existing work.

### **3.2 Hardware, Hangers and Support**

- .1 Provide 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.
- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where hangers are suspended from concrete slabs, install inserts before concrete is placed using inserts designed for the specific purpose.

- .4 Where built-in inserts are inaccessible due to subsequent installation of conduits, ducts, pipes or other installations, use anchors appropriate to the load requirements. Locate anchors to avoid damage to reinforcing bars.
- .5 Verify that 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.
- .6 Where fastener installations are suspect, conduct on-site tests of installed fasteners, employing an independent testing laboratory acceptable to the Engineer, using properly engineered and calibrated force measuring meters.
- .7 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.
- .8 Provide reinforcing or connecting supports where required to distribute the loading to the structural components.
- .9 Do not use wood plugs and hammer impact fasteners. Anchors in floor topping fills are not acceptable. Secure anchors in floors to the structure.
- .10 Where a performance requirement is specified, submit engineering calculations and written verification signed by a registered professional structural engineer that the installation has been inspected and is structurally sound and in accordance with design requirements.
- .11 Fastenings which cause spalling or cracking of the structure or products to which anchorage is made are not acceptable.
- .12 Space anchors within limits of load bearing or shear capacity and ensure they provide positive permanent anchorage.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .14 Secure equipment to hollow and solid masonry, tile and plaster surfaces with nylon shields.
- .15 Secure equipment to poured concrete with expandable inserts and nylon shields.
- .16 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .17 Fasten exposed conduit or cables to building construction or support system using straps.
- .18 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .19 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .20 Do not mount bare aluminum conduit directly on concrete surfaces.
- .21 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .22 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Engineer.

### **3.3 Conductor Disconnection or Removal**

- .1 The Contractor shall ensure that all conductors, wires or cable that the Contractor disconnects, or has disconnected on their behalf by others, shall be uniquely identified on both sides of the disconnection and the other end of the conductor, wire and cable.

- .2 Fully remove all cables and surface wireways identified for the removal, unless otherwise noted on the drawings or directed by the Engineer.
- .3 All abandoned metal wireways, concealed or identified to remain, shall be bonded to ground using approved bonding material and methods. All wireways shall be capped using individual or grouped covers. The covers to be bonded to ground as required.
- .4 Phase rotations on power cables, polarities on direct current systems shall also be identified. No additional monies shall be payable for additional costs incurred on reconnection or otherwise for failure to adequately identifying conductors, wires or cables.

### 3.4 Finishes

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original factory finish.
- .2 Clean, prime and paint exposed non-galvanized hangers, racks and fastenings to prevent rusting.

### 3.5 Manufacturer's Quality Control & Factory Testing

- .1 Manufacturer to provide proof of quality control program in accordance with CAN/CSA-Q9000-2.
- .2 All factory tests required by the latest CSA, UL/CUL, NEMA, ANSI and or IEEE standards shall be performed for complete assembly, including operation of all power and control components.
- .3 All assemblies and sub-assemblies shall be inspected and/or tested for conformance to the manufacturer's engineering and quality assurance specifications. The specifications shall be available to the Engineer upon request.
- .4 Where manufacturer's specifications are not available, provide manufacturer's quality control and testing in accordance with applicable paragraphs of the Section 16030 Commissioning of Electrical System.
- .5 Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
- .6 Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.
- .7 Control and power wiring and bus work shall be point-to-point verified and continuity checked.
- .8 The assembly and power components shall have been tested in a high-power laboratory to prove adequate mechanical and electrical capabilities.
- .9 A certified test report of all standard production tests shall be available to the Engineer upon request.
- .10 Factory tests as outlined above and as specified in the subsequent sections shall be witnessed by the Owner's representative.
  - .1 The Manufacturer shall notify the Engineer two (2) weeks prior to the date the tests are to be performed.
  - .2 The Manufacturer shall include the cost of transportation, meals and lodging as required.

### **3.6 Equipment Installation – General Requirements**

- .1 Fully inspect shipments for damage and report damage to the Manufacturer and file claim upon shipper, if necessary.
- .2 Verify assembly and components nameplates.
- .3 Verify minimum equipment clearances.
- .4 Follow Manufacturer's installation instructions.
- .5 Rig equipment and assemblies into final location, and install and secure on level surface, channel bases, rigid, plumb and square to building floors and walls.
- .6 Ensure moving and working parts are lubricated where required.
- .7 Check all removable subassemblies and equipment for easy removal and re-insertion.
- .8 Torque all bolted connections made in the field to manufacturers recommended values using a calibrated tool.
- .9 Remove wedges, clamps from breakers, contactors and relays.
- .10 Provide all power and control wiring and install and support properly.
- .11 Interface all local and remote devices into the control wiring and operational systems for each load, including field power and control connections as indicated. Control and power wiring shall be as shown on the Drawings and specifications except as modified by the approval and submittal process.
- .12 After installation, render entire enclosures rodent and insect proof by means of steel plates, grouting, screens, etc.
- .13 Energize equipment for commissioning, interim and in-service condition.

### **3.7 Manufacturer's Certification**

- .1 The Manufacturer's Representative shall provide technical direction and assistance to the Contractor in the general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- .2 A qualified factory-trained Manufacturer's Representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- .3 Submit manufacturer's certification letter for the review by the Engineer prior to applying for the substantial performance.

### **3.8 Short-Circuit Protective Devices and Arc-Flash Analysis**

- .1 The Contractor is to be responsible and provide a complete model of the entire electrical system, including new works, existing equipment, and electrical distribution. The model shall be completed in ETAP version 12.6.
- .2 The electrical analysis shall be run for the worse case scenario. There shall also be analysis when connected to utility and emergency power source when applicable.
- .3 Obtaining Utility data is the responsibility of the Contractor.
- .4 A model shall be completed submitted prior to the installation and commissioning of equipment for approval by the Engineer.
- .5 An "As Built" model shall be completed and submitted to the Engineer for approval once the electrical system is fully installed and commissioned.

- .6 The Contractor is to be responsible and provide a single report consisting of the following:
  - .1 Provide Arc-flash hazard analysis as per CSA Z462 and IEEE 1584 Standards. Print Arc-flash hazard labels on high quality UV resistant vinyl labels with self-adhesive back (4"x6" in size) and affix it on the electrical equipment. The labels shall be approved by the Engineer before printing.
  - .2 Short-circuit analysis;
  - .3 Protective device coordination study;
  - .4 Arc-flash hazard analysis;
  - .5 Arc-flash hazard labels
- .7 The study is to include the complete distribution system under the project, including individual feeders. All disconnect switches shall be provided with Arc-flash label.
  - .1 Study shall be stamp by a license and practicing Professional Engineer of Ontario.
- .8 Provide thermal transfer colour laser printed Arc-flash labels. Labels to be submitted by Contractor in PDF copy, 100x150mm size, in accordance with CSA Z462 Standard.

### **3.9 Training**

- .1 The Manufacturer's Qualified Technical Representative shall provide a training session for up to six (6) Owner's representatives for minimum of half (1/2) workday per equipment type at the job site location determined by the Owner.
- .2 The Contractor is responsible for coordination and scheduling of such a work.
- .3 The training program shall consist of, but is not limited to:
  - .1 Review of the technical data sheets, drawings and schedules.
  - .2 Review of the factory record shop drawings and the placement of components.
  - .3 Review of the functional and operational requirements of each type of sub-assemblies, components and wiring.
  - .4 Review component and sub-assembly replacement procedures.
  - .5 Discuss the maintenance timetable and procedures of an ongoing maintenance program.
  - .6 Review and discuss testing and calibration timetable, procedures and equipment.
  - .7 Provide six (6) three-ring binders, complete with copies of drawings and another course material covered. Include within each binder an electronic copy on USB drives.

### **4.0 Definitions**

- .1 For this and all related contracts, specification, drawings and provisions, the following definitions will apply:
  - .1 Assembly – a power and control equipment, devices and wiring, which factory or field manufactured and placed within enclosure.
  - .2 Concealed – hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions, etc.
  - .3 Exposed – work normally visible, including Work in equipment rooms, tunnels, and similar accessible spaces.
  - .4 Provide – supply, install and connect complete.
  - .5 Retrofit or replace – remove existing, and provide new complete.

- .6 Install – install and connect complete.
- .7 Furnish or supply – supply only.
- .8 Work – the execution of all items in this contract.
- .9 Days – a required number of working days.
- .10 Complete – installed and running to the satisfaction of the Engineer.
- .11 Restoration – repair and renewal to good condition to the satisfaction of the Engineer.
- .12 Labour – persons with appropriate certified skills to complete Work.
- .13 Materials – all things required to complete Work.
- .14 Commissioning – work by specialist sub-contractors to test, verify and certify the proper condition, wiring connections and operation of the subject equipment.
- .15 Remove – consult and coordinate with the Owner, make the subject equipment safe, disconnect and remove all subject electrical and support materials, cables and wiring, back to the source of electrical supply, and dispose offsite in a safe and approved manner, all according to Engineer’s instructions and applicable Regulations.
- .16 Replace – remove and provide.
- .17 Decommissioning – take out of service in coordination with the Engineer and the Owner.
- .18 Returned – supply the subject equipment in the possession of the contractor to the designated party.
- .19 Verification – inspect, measure and test using approved specialist sub-contractors as may be requested by the Engineer.
- .20 Start-up – that process after commissioning to coordinate with the Engineer and Owner, to turn on and leave running the subject equipment.

**End of Section**

## 16030 Commissioning of Electrical Systems

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for common criteria and characteristics, methods and execution for the commissioning services that include inspection, testing and start-up of electrical works specified under the Electrical Division.
- .2 Arrange, coordinate, and pay for the field quality control, start-up and commissioning.
- .3 Provide all material, equipment, labour, and technical supervision to perform inspection, test, commissioning and start-up for the period as required to complete the installation.

#### 1.2 Standards

- .1 ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

#### 1.3 Quality Assurance

- .1 Provide qualified trades persons, certified testing agencies, factory trained manufacturer's representative, and/or third-party independent engineering service company for commissioning services.
  - .1 Submit the names of all representatives including personnel to be used during the Commissioning activities for Engineer's Approval.
  - .2 Notwithstanding, electrical assemblies and equipment such as switchgear, switchboard, MCCs, transformers, generator, VFDs, etc., shall be commissioned by a certified testing agencies, qualified factory-trained manufacturer's representative, or qualified third-party independent engineering service company.

#### 1.4 Commissioning – General Requirements

- .1 The purpose of the commissioning process is to fully test all systems including architectural, mechanical and electrical components and operating procedures by challenging these systems to realistic operating conditions.
- .2 The Contractor shall arrange, coordinate and pay for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification. The cost associated with this requirement shall be included as part of the tender price.
- .3 The Commissioning activities for the electrical systems must have available up to date as-built drawing information and accurate Operations and Maintenance Manuals.
- .4 Confirm all scheduled activities have identified personnel available.
- .5 Verify all systems are in compliance with the contract design and operational requirements.
- .6 Perform commissioning and start-up in accordance with manufacturer's published procedures.
- .7 Where systems or equipment do not operate as required, make the necessary corrections or modifications, retest and recommission.

- .8 The Contractor to provide the services of a qualified factory-trained Manufacturer's Representative, or third-party independent engineering service company, to assist in installation of the equipment for the period as required to complete the installation. The Manufacturer's Representative shall provide technical direction and assistance to the Contractor in the general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- .9 The following is the minimum work that shall be performed by the Contractor, or third-party independent engineering service company engaged by the Contractor, on the electrical system excluding work to be done on the electrical assemblies such as switchgear, switchboard, MCCs, transformers, generator, VFDs, etc.:
  - .1 Verification of the power distribution system, circuits originating from branch distribution panels (including distribution and lighting panels), and equipment feeder circuits, including:
    - .1 Verification of branch circuits bolted/lug connections
    - .2 Branch circuit feeders insulation test
    - .3 Phasing
    - .4 Verification of voltage and voltage drop
    - .5 Load balancing
    - .6 Grounding system resistance
  - .2 Verification and operational testing of the lighting, and emergency lighting system, and their associated controls.
  - .3 Verification and operational testing of the fire alarm and communication systems.
  - .4 Verification and operational testing of the motors, heaters and other electrical equipment operation, including associated control equipment sequenced operation of systems where applicable.
- .10 The following is the minimum work that shall be performed by the Manufacturer's Service Representative, or third-party independent engineering service company engaged by the Manufacturer, for the electrical assemblies such as switchgear, switchboard, MCCs, transformers, generator, VFDs, etc.:
  - .1 Inspection and adjustments of the complete assembly and all power and control components.
  - .2 Verify all factory and field-assembled bolted connections.
  - .3 Perform insulation tests on each phase and verify low-resistance ground connection on ground bus.
  - .4 Verify basic operation of each power and control sub-assembly.
  - .5 Ensure correct address and settings of the overloads and protective relaying are set in accordance with the Drawings.
  - .6 Calibrate, program and setup any solid-state protection, metering or control units/relays for their intended purpose and make written notations of adjustments on record drawings.
  - .7 Verify and test communication network to ensure proper termination of the network cables, including the verification of the MAC IDs.
- .11 Make available calibrated and verified instruments, meters, and test equipment required to conduct tests. Where indicated, provide specific test equipment.
- .12 All the tests to be carried out in the presence of the Engineer.
  - .1 Notify the Engineer two (2) weeks prior to the date the tests are to be performed.

- .2 Proceed with tests without witnessing only with prior written notification from the Engineer.

## **1.5 Submittals**

- .1 Prepare commissioning activity procedures and schedule document prior to conducting commissioning activities for review and approval by the Engineer.
  - .1 The Contractor shall be responsible for ensuring all activities are properly documented and coordinated.
- .2 As-built construction and shop drawings and data sheets must be available two (2) weeks prior to commissioning for review and use by the Engineer and Commissioning Team prior to the start of the commissioning activities.
- .3 The Contractor shall be responsible to update all documentation with information and any changes duly noted during the Commissioning.
- .4 Generate and provide to the Engineer field commissioning report.
  - .1 Scan hand-written or generate draft copy of the field report immediately after the tests are performed.
  - .2 Not later than one (1) week after start-up and commissioning is complete, provide one final (1) copy in original electronic PDF format of individual subsystem commissioning reports.
  - .3 Not later than two (2) weeks after last commissioning activity is completed, provide one final (1) copy in original electronic PDF format of compiled, tabulated and indexed overall system commissioning report.
  - .4 This is in addition to the requirements of the Installation and Maintenance Manuals.

## **2.0 Products**

- .1 Provide calibrated and verified instruments, meters, and test equipment required to conduct tests. Where indicated, provide specific test equipment.

## **3.0 Execution**

### **3.1 Low Voltage Power and Control Cables**

- .1 **Related Sections**
  - .1 Section 16120 Wires and Cables
- .2 **Visual and Mechanical Inspection**
  - .1 Compare cable data with drawings and specifications, and report discrepancies.
  - .2 Inspect cables for physical damage and proper connection in accordance with single-line diagrams.
  - .3 Inspect compression-applied connectors for correct cable match and indentation.
  - .4 Test cable mechanical connections by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
  - .5 Check cable color coding with specifications and applicable codes.
  - .6 Verify cables are tagged per drawings and specifications.
- .3 **Electrical Tests**

- .1 Perform **cable insulation resistance** test on each conductor with respect to ground and adjacent conductors for one (1) minute.
  - .1 Test voltages and minimum insulation resistance shall be in accordance with manufacturer's recommendations corrected to nominal temperature; in absence of manufacturer's data use .
  - .2 Values less than specified should be investigated.
  - .3 Also evaluate results by comparison with cables of same length and type.

## 3.2 Induction Motors

### .1 Related Sections

- .1 Section 16222 Motors.

### .2 Visual and Mechanical Inspection

- .1 Inspect for physical damage and compare nameplate data with drawings and specifications.
- .2 Inspect for proper anchorage, mounting, grounding, connection, and lubrication.
- .3 When applicable, perform special tests such as air gap spacing and pedestal alignment.
- .4 Check for unusual mechanical or electrical noise or signs of overheating during initial test run.

### .3 Electrical and Mechanical Tests

- .1 Perform **insulation resistance (IR)** test on generator winding phase-to-ground corrected to 40°C, and calculate **polarization index (PI)** where practicable, in accordance with ANSI/IEEE Std. 43.
  - .1 Record IR values for one (1) minute.
  - .2 Where  $IR_{1min} < 5T\Omega$ , or reading is below maximum scale, record subsequent 1-minute intervals to ten (10) minutes, and calculate polarization index.
  - .3 Test voltages, minimum IR and PI values shall be in accordance with , and (all derived from ANSI/IEEE Std. 43).
  - .4 Values less than specified should be investigated.
- .2 Perform **rotation test** to ensure proper shaft direction.
- .3 Perform **vibration base-line test**; plot amplitude versus frequency for each main bearing cap.
  - .1 Vibration levels shall not exceed manufacturer's recommendations.
- .4 Test motor starter and protective relays prior to energizing the motor.
- .5 Check resistance temperature detector (RTD), thermistor, leakage and vibration sensors for conformance with drawings. Check that metering or relaying devices using the sensors are of the proper rating.
- .6 Perform **15-min running test** under operating conditions.
  - .1 Record average current, voltage, real/reactive power, power factor temperature, maximum current during start, and duration of the start.
  - .2 Evaluate relative to load conditions and nameplate data.
  - .3 For VFD driven equipment record condition under between 50-100% output frequency in 5% increments.
- .7 Perform **start-up test under** operating conditions for motors rated 575V and above and 50HP and above.

- .1 Record transient response of voltage and current phasors, frequency, and real/reactive power and power factor, and motor shaft speed, minimum 16 times per cycle during entire duration of the start.
- .2 Repeat test with utility and generator power.
- .3 For RVSS controlled equipment, repeat test for full-voltage and 300% current limit condition.
- .8 Check that the motor space heater circuit is in proper operating condition and in accordance with drawings and specifications.
- .9 Functionally test customer specified alarms and statuses.

### 3.3 Low Voltage Distribution Transformers

#### .1 Related Sections

- .1 Section 16470 Low Voltage Distribution Transformers

#### .2 Visual and Mechanical Inspection

- .1 Compare equipment and components nameplate data with drawings and specifications, and report discrepancies.
- .2 Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
- .3 Inspect bolted electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .4 Perform specific inspections and mechanical test as recommended by manufacturer.
- .5 Make a close examination for shipping brackets or fixtures that many not have been removed during original installation. Ensure that resilient mounts are free.
- .6 Verify proper core and equipment grounding.
- .7 Thoroughly clean unit prior to testing.
- .8 Verify taps and connect transformer to desired tap, is applicable.

#### .3 Electrical Tests

- .1 Perform **winding insulation resistance** test winding-to-winding and each winding-to-ground for one (1) minute.
  - .1 Test voltages and minimum insulation resistance shall be in accordance with manufacturer's recommendations corrected to nominal temperature; in absence of manufacturer's data use .
  - .2 Values less than specified should be investigated.
- .2 Perform **turns ratio** tests for each winding at all tap positions.
  - .1 Results should not deviate more than 0.5% from adjacent coils or calculated ratio.
- .3 Perform **winding resistance** measurements for each winding at nominal tap with a low resistance ohmmeter.
  - .1 Test results should compare within 1% of adjacent windings.
- .4 Energize primary winding with system voltage. Measure secondary voltage with the secondary load disconnected. Record results.

### 3.4 Panelboards

#### .1 Related Sections

.1 Section 16441 Panelboards

**.2 Visual and Mechanical Inspection**

- .1 Inspect for physical, electrical and mechanical condition.
- .2 Compare panelboard and circuit breaker nameplate data with drawings and specifications, and report discrepancies.
- .3 Inspect for proper mounting, required clearances, physical damage, dents, scratches, fit and missing hardware.
- .4 Check for proper grounding and bonding.
- .5 Inspect all bus bolted electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .6 Exercise all breakers.
- .7 Perform breaker manual push-to-trip test.

**.3 Electrical Tests**

- .1 Perform **bus insulation resistance** test on each bus section, phase-to-phase and phase-to-ground for one (1) minute, with all breakers opened.
- .2 Perform **breaker insulation resistance** test from pole to pole (on 2- and 3-pole breakers) and from each pole to ground with breaker closed (all other breakers opened), and across open contacts of each pole.
- .3 Insulation resistance test voltages and minimum resistances shall be in accordance with .
  - .1 Values less than indicated or manufacture's recommendations should be investigated.
- .4 Perform combined breaker and bus connection **contact resistance** test using low-resistance ohmmeter. With breakers closed, record resistance measured from fixed location on each bus and load side of each breaker pole connected to bus under the test.
  - .1 Compare contact resistance values to adjacent poles and similar breakers. Investigate deviations of more than 50%. Investigate any value exceeding manufacturer's recommendations.

**3.5 Low Voltage Circuit Breakers and Switches**

**.1 Related Sections**

- .1 Section 16476 Low Voltage Circuit Breakers
- .2 Section 16414 Low Voltage Disconnect Switches

**.2 Visual and Mechanical Inspection**

- .1 Compare nameplate data with drawings and specifications, and report discrepancies.
- .2 Inspect for physical and mechanical condition and check for proper mounting, anchorage, and grounding.
- .3 Inspect electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .4 Operate switches and breakers to ensure smooth operation.
- .5 Perform breaker manual push-to-trip test.

**.3 Electrical Tests**

- .1 Perform **switches and breaker contact resistance** test using low-resistance ohmmeter.
  - .1 Compare contact resistance values to adjacent poles and similar breakers. Investigate deviations of more than 50%. Investigate any value exceeding manufacturer's recommendations.
- .2 Perform **switches and breaker insulation resistance** test from pole to pole and from each pole to ground with breaker closed, and across open contacts of each phase.
  - .1 Test voltages and minimum resistances shall be in accordance with .
  - .2 Values less than indicated or manufacture's recommendations should be investigated.
- .3 For breaker with **electronic trip unit**, perform functional test of the trip unit by **secondary current injection** using manufacturer specific test unit.
  - .1 Record separately the tests for pickup and time delay for long-time, short-time, instantaneous and ground-fault functions.
  - .2 Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

### 3.6 Low Voltage Starters, Contactors and Variable Frequency Drives

#### .1 Related Sections

- .1 Section 16485 Low Voltage Contactors and Combination Starters
- .2 Section 16455 Low Voltage Variable Frequency Drives

#### .2 Visual and Mechanical Inspection

- .1 Compare nameplate data with drawings and specifications, and report discrepancies.
- .2 Inspect for physical and mechanical condition and check for proper mounting, anchorage, and grounding.
- .3 Inspect electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .4 Operate motor circuit protector or switch to ensure smooth operation.
- .5 Perform manual push-to-trip test of motor circuit protector.

#### .3 Electrical Tests

- .1 Perform **contact resistance test** of each **protective device** (motor circuit protector or switch) and **starter** using low-resistance ohmmeter.
  - .1 Compare contact resistance values to adjacent poles and similar breakers. Investigate deviations of more than 50%. Investigate any value exceeding manufacturer's recommendations.
- .2 Before proceeding with insulation resistance tests, control transformer to be isolated, and all other protective devices in the assembly to be opened.
  - .1 Perform **starter insulation resistance** test from pole to pole and from each pole to ground with starter contacts closed and protective device open, and across open contacts of each phase.
  - .2 Perform **protective device insulation resistance** test from pole to pole and from each pole to ground with protective device closed and starter open, and across open contacts of each phase.
  - .3 Test voltages and minimum resistances shall be in accordance with .

- .4 Values less than indicated or manufacture's recommendations should be investigated.

#### **.4 Setup and Programming**

- .1 Compare motor circuit protector range and setting with motor full-load current rating and motor starting current. Adjust as necessary to ensure settings are above motor starting current, maximum 1300% of full load current; account for manufacturer specified trip tolerances.
- .2 Program and setup overload relays, RVSSs and VFDs to suit each motor nameplate and operational parameters.
  - .1 Compare motor protective overload function range and setting with motor full load current rating to verify proper sizing. Adjust as necessary for motor service factor, and if power factor correction capacitors are connected on load side of overload relay.
  - .2 Adjust additional current and voltage based protective and alarm functions as required. Minimum protective functions:
    - .1 Jam Trip – 400%
    - .2 Jam Delay – 2s
    - .3 Current Unbalance – 15%
    - .4 Current Unbalance Delay – 10s
    - .5 Current Phase Loss – 60%
    - .6 Current Phase Loss Delay – 5s
    - .7 Ground Fault – Disabled, unless requested to be enabled.
    - .8 Phase Rotation – Set to system rotation (ABC, ACB)
    - .9 Under Current – 50%
    - .10 Under Current Delay – 10s
    - .11 Low Power - Disabled
    - .12 Under Voltage – 90% of load rated voltage
    - .13 Under Voltage Delay – 10s
    - .14 Over Voltage – 110% of load rated voltage
    - .15 Over Voltage Delay – 10s
    - .16 Reset delay – 10s
  - .3 For VFDs, apply minimum and maximum speed setpoints.
  - .4 For VFDs disable reverse control unless load is reversible.
  - .5 For RVSSs and VFDs, apply starting / acceleration and stopping / decelerations setpoints.
  - .6 Verify setpoints are within limitations of the load coupled to the motor.
  - .7 Program local and remote control sources, and speed references for VFDs.
- .3 For communicating I/O modules, overload relays, RVSSs and VFDs, program communicating modules with MAC IDs / address, baud rate / speed, and required input/output data assemblies.
- .4 For ethernet communicating devices ensure that all devices are programmed with common firmware.
- .5 Devices with web servers ensure that web server operates with Microsoft Internet Explorer, latest revision. Program device web server to include equipment tag name where provided and equipment descriptions.
- .6 Program device for the following situations for communication loss:

- .1 When control and indication from network, device shall be programmed to not fault, and stop.
- .2 When indication only from network, device shall be programmed to not fault and continue run as commanded by control circuits.
- .7 Devices with event logger ensure date and time is set correctly and events are recording the correct time.
- .8 Energize control circuit by applying secondary control test voltage, or if applicable, by applying power.
- .9 Perform point-to-point verification of all control wiring.

### **.5 Startup**

- .1 Perform start-up of starters, RVSSs and VFDs in accordance with manufacturer's published data.
- .2 Operational tests shall conform to system design requirements.
- .3 Verify operation by initiating control devices to affect proper starting, stopping, direction or speed change, and speed variation for VFDs, where applicable.
  - .1 Local and field manual control devices and/or OITs;
  - .2 Hardwired remote automatic control devices; and
  - .3 Hardwired and/or communicating remote manual and automatic PLC and SCADA control.
- .4 Verify proper actuation of local and remote hardwired indication devices.
- .5 Verify proper actuation of discrete and analog data, indication, statuses and alarms at PLC and SCADA.
- .6 Energize load.
  - .1 Record frequency, voltage, power, and current, including corresponding process variable where applicable (e.g. flow, level, pressure, etc.).
    - .1 For VFDs motors, vary speed between minimum and maximum speed setpoints in 5% increments and record parameters at every step.
  - .2 Observe motor and load for unusual vibration and noise.

## **3.7 Engine Generators**

### **.1 Related Sections**

- .1 Section 16620 Standby Power Generation

### **.2 Visual and Mechanical Inspection**

- .1 Compare nameplate data with drawings and specifications, and report discrepancies.
- .2 Inspect for physical and mechanical condition and check for proper mounting, anchorage, and grounding.
- .3 Inspect electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .4 Inspect generator circuit breaker in accordance with the applicable Circuit Breaker Paragraph.

### **.3 Electrical and Mechanical Tests**

- .1 Perform **insulation resistance (IR)** test on generator winding phase-to-ground corrected to 40°C, and calculate **polarization index (PI)** where practicable, in accordance with ANSI/IEEE Std. 43.
    - .1 Record IR values for one (1) minute.
    - .2 Where  $IR_{1min} < 5T\Omega$ , or reading is below maximum scale, record subsequent 1-minute intervals to ten (10) minutes, and calculate polarization index.
    - .3 Test voltages, minimum IR and PI values shall be in accordance with , and (all derived from ANSI/IEEE Std. 43).
    - .4 Values less than specified should be investigated.
  - .2 Verify settings and operation, and functionally test generator controller (GC), operating interface and power metering.
  - .3 Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other features as applicable.
  - .4 Functionally test customer specified alarms and statuses.
  - .5 Perform **vibration base-line test**; plot amplitude versus frequency for each main bearing cap.
    - .1 Vibration levels shall not exceed manufacturer's recommendations.
  - .6 Perform **phase rotation test** to determine compatibility with load requirements.
  - .7 Perform **load bank test**.
    - .1 Test schedule:
      - .1 25% rated for 30 minutes;
      - .2 50% rated for 30 minutes;
      - .3 75% rated for 30 minutes; and
      - .4 100% rated for 30 minutes.
    - .2 Record voltage, frequency, load current, oil pressure, and coolant temperature at periodic intervals during test.
    - .3 Load test results shall demonstrate the ability of the unit to deliver rated load for the test period.
  - .8 Perform **step-load pickup and rejection test**.
    - .1 Tests schedule:
      - .1 0-50% load;
      - .2 50-100% load;
      - .3 0-100% load;
      - .4 100-50% load;
      - .5 50-0% load; and
      - .6 100-0% load.
    - .2 Record transient voltage and frequency response; minimum sampling frequency 6kHz.
    - .3 Step load test results shall demonstrate the ability of the unit to provide required voltage and frequency control.
  - .9 Perform **power failure test** on the entire system by opening the power supply from the utility service and observing proper operation of the system for at least 2 hours.
  - .10 Test generator circuit breaker in accordance with the applicable Circuit Breaker Paragraph.
- .4 Setup and Programming

- .1 Set time and date to current. Confirm that event logger is recording correct dates.
- .2 Generator cooldown shall be 300s or value recommended by MFG. which ever is greater.

### 3.8 Transfer Switches

#### .1 Related Sections

- .1 Section 16621 Low Voltage Transfer Switches

#### .2 Visual and Mechanical Inspection

- .1 Compare nameplate data with drawings and specifications, and report discrepancies.
- .2 Inspect for physical and mechanical condition and check for proper mounting, anchorage, and grounding.
- .3 Inspect electrical connections for high resistance by verifying tightness using calibrated torque wrench in accordance with published manufacturer's data.
- .4 Perform manual transfer operation.
- .5 Confirm proper lubrication.
- .6 Check switch to ensure positive mechanical interlock between normal and alternate sources.
- .7 Ensure manual transfer warnings are attached and visible.
- .8 Check that all covers, barriers, and doors are secure.

#### .3 Electrical and Operational Tests

- .1 Perform **contact resistance** test across all main contacts using low-resistance ohmmeter.
  - .1 Compare contact resistance values to all poles. Investigate deviations of more than 50%. Investigate any value exceeding manufacturer's recommendations.
- .2 Perform **insulation resistance** test from pole to pole and from each pole to ground with switch in both source positions, and across open contacts of each pole.
  - .1 Test voltages and minimum resistances shall be in accordance with .
  - .2 Values less than indicated or manufacture's recommendations should be investigated.
- .3 Verify settings and operation of automatic transfer controller (ATC).
- .4 Calibrate and test ATC function, all relays and timers, including voltage and frequency-sensing relays, in-phase monitor (synchronism check), engine start and cooldown timers, transfer and retransfer timers, etc.
- .5 Perform automatic transfer tests:
  - .1 Simulate loss of normal power.
  - .2 Return to normal power.
  - .3 Simulate loss of emergency power.
  - .4 Simulate all forms of single-phase conditions.
- .6 Monitor and verify correct operation and timing of the following simulations:
  - .1 Normal voltage-sensing relays.
  - .2 Engine start sequence.

- .3 Time delay upon transfer.
- .4 Alternate voltage-sensing relays.
- .5 Automatic transfer operation.
- .6 Interlocks and limit switch function.
- .7 Time delay and retransfer upon normal power restoration.
- .8 Engine cooldown and shutdown feature.
- .7 Functionally test customer specified alarms and statuses.
- .4 Setup and Programming
  - .1 Set time and date to current. Confirm that event logger is recording correct dates.
  - .2 Time Delays:
    - .1 Normal to Emergency Delay – 30s
    - .2 Emergency to Normal Delay – 300s
    - .3 Pre-Transfer Delay – 0s
    - .4 Post Transfer Delay – 0s
    - .5 Engine 1 Start Delay – 5s
    - .6 Engine Cool Delay – 0s
    - .7 Emergency Fail Delay – 2s
    - .8 Neutral Delay – 30s or time required to allow all equipment to fully de-energize whichever is longer.
  - .3 Dropout Setpoints
    - .1 Under Voltage – 90% Ensure set higher than load protection connected to emergency system.
    - .2 Over Voltage – 110% Ensure set lower than load protection connected to emergency system.
    - .3 Under Frequency – 94%
    - .4 Over Frequency – 106%
    - .5 Phase Loss – 40%
    - .6 Unbalanced Current – 12%
  - .4 Pickup Setpoints
    - .1 Under Voltage – 98%
    - .2 Over Voltage – 108%
    - .3 Under Frequency – 96%
    - .4 Over Frequency – 104%
    - .5 Phase Loss – 30%
    - .6 Unbalanced Current – 10%

#### 4.0 Tables

**Table 16030.1 Insulation Resistance Test Voltages**

Voltage Rating/Class	Test Voltage	IR <sub>1 min</sub>
250V, 300V	500Vdc	50MΩ
480V, 600V, 1,000V	1kVdc	100MΩ

<b>2.5kV</b>	2.5kVdc	500MΩ
<b>5kV</b>	2.5kVdc	1TΩ
<b>15kV</b>	2.5kVdc	5TΩ
<b>28kV</b>	5kVdc	20TΩ
<b>34.5kV and above</b>	15kVdc	100TΩ

**Table 16030.2 Dielectric Withstand Test Voltages**

<b>Rated Max Voltage</b>	<b>Max AC Test Voltage</b>	<b>Max DC Test Voltage</b>
<b>4.76kV</b>	14.3kVac	20.3kVdc
<b>15kV</b>	27kVac	37.5kVdc
<b>27kV</b>	45kVac	
<b>38kV</b>	60kVac	
<b>48.3kV</b>	100kVac	

**Table 16030.3 Transformer Insulation Resistance Test Voltages**

<b>Voltage Rating</b>	<b>Test Voltage</b>	<b>IR<sub>1 min</sub> Liquid-Filled</b>	<b>IR<sub>1 min</sub> Dry-Type</b>
<b>0 - 600V</b>	1kVdc	100MΩ	500MΩ
<b>601V – 5kV</b>	2.5kVdc	1TΩ	5TΩ
<b>Above 5kV</b>	5kVdc	5TΩ	25TΩ

**Table 16030.4 Rotating Machines Insulation Resistance Test Voltages**

<b>Voltage Rating</b>	<b>Minimum Test Voltage</b>
<b>&lt;1kV</b>	500Vdc
<b>1-2.5kV</b>	1kVdc
<b>2.5 – 5kV</b>	2.5kVdc
<b>5-12kV</b>	5kVdc
<b>Above 12kV</b>	10kVdc

**Table 16030.5 Rotating Machines Minimum Insulation Resistance (IR)**

<b>IR<sub>1 min</sub> = kV + 1</b>	For most windings made before about 1970, all field windings, and others not described below
<b>IR<sub>1 min</sub> = 100MΩ</b>	For most dc armature and ac windings built after about 1970 (formwound coils)
<b>IR<sub>1 min</sub> = 5MΩ</b>	For most machines with random-wound stator coils and formwound coils rated below 1 kV

**Table 160300.6 Rotating Machines Minimum Polarization Index (PI)**

<b>PI<sub>min</sub> = 1.5</b>	Thermal Class A
<b>PI<sub>min</sub> = 2</b>	Thermal Class B, F and H

**End of Section**

## 16110 Raceways and Boxes

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for electrical raceways and boxes.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Seismic Requirements

- .1 All materials specified under this Section shall be designed and installed to the seismic requirements as detailed in accordance with Section **Error! Reference source not found.**

#### 1.3 Standards

- .1 CSA C22.2 No.18.1 - Metallic Outlet Boxes
- .2 CSA C22.2 No.18.2 - Nonmetallic Outlet Boxes
- .3 CSA C22.2 No.18.3 - Conduit, Tubing, and Cable Fittings
- .4 CSA C22.2 No.18.4 - Hardware for the Support of Conduit, Tubing, and Cable
- .5 CSA C22.2 No.18.5 - Positioning Devices
- .6 CSA C22.2 No.26 - Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings
- .7 CSA C22.2 No.40 - Cutout, Junction and Pull Boxes
- .8 CSA C22.2 No.45.1 - Electrical Rigid Metal Conduit - Steel
- .9 CSA C22.2 No.45.2 - Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel
- .10 CSA C22.2 No.56 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
- .11 CSA C22.2 No.76 - Splitters
- .12 CSA C22.2 No.85 - Rigid PVC Boxes and Fittings
- .13 CSA C22.2 No.158 - Terminal Blocks
- .14 CSA C22.2 No.211.1 - Rigid Types EB1 and DB2/ES2 PVC Conduit
- .15 CSA C22.2 No.211.2 - Rigid PVC (Unplasticized) Conduit
- .16 CSA C22.2 No.227.1 - Electrical Nonmetallic Tubing
- .17 CSA C22.2 No.227.2 - Liquid-Tight Flexible Nonmetallic Conduit
- .18 CSA C22.2 No.227.3 - Nonmetallic Mechanical Protection Tubing (NMPT)
- .19 CSA C22.3 No.7 - Underground Systems

#### 1.4 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

- .1 Provide product data sheets for each type of raceway and boxes used.
- .2 Provide shop drawings and product data sheets for each type of cable tray.

## **2.0 Products**

### **2.1 Non-metallic Conduits and Tubing**

- .1 Rigid PVC conduit (PVC) to CSA C22.2 No. 211.2, suitable for concrete encasement, direct buried and above ground installation, including solvent weld joints and factory-made expansion joints, elbows, bends, and couplings.
- .2 Flexible liquid-tight corrugated non-metallic conduit (LFNC), to CSA C22.2 No. 227.2.1, supplied in a continuous coil of the proper length; with heavy-duty couplings and connectors.
- .3 Flexible electrical non-metallic tubing (ENT) and nonmetallic mechanical protection tubing (NMPT) to CSA C22.2 No. 227.1 and 227.3, supplied in a continuous coil of the proper length, and non-metallic couplings, connectors and boxes, suitable for concrete encasement.
- .4 Factory made bell-end fittings, connectors, terminations and elbows for rigid PVC conduits to CSA C22.2 No.85; weatherproof expansion fittings for linear expansion at entry to panels; weatherproof expansion fittings suitable for minimum 100mm linear expansion and 19mm deflection in all directions.

### **2.2 Metallic Conduits and Tubing**

- .1 Rigid aluminum conduit (RAC) to CSA C22.2 No. 45.2; watertight, factory-made and threaded fittings, connectors, and terminations made with rigid couplings, concrete-tight where required; PVC coated where specified.
- .2 Flexible liquid-tight metal conduit (FMC) to CSA C22.2 No. 56, aluminum with PVC jacket, with liquid-tight conduit connectors and fittings.
- .3 Conduit and fittings to CSA C22.2 No. 18.3, including conduit locknuts, bushings, conduit bodies, and entrance elbows; wweatherproof expansion fittings with internal bonding jumper/assembly suitable for minimum 100mm linear expansion and 19mm deflection in all directions.

### **2.3 Outlet and Conduit Boxes**

- .1 Outlet boxes, conduit boxes and fittings, metallic to CSA C22.2 No. 18.1 and non-metallic to CSA C22.2 No. 18.2, of the style and construction to match wireways used; sized to CSA C22.1, larger sizes for special devices; with blank cover plates for boxes without wiring devices; gang boxes where wiring devices are grouped, and with barriers where outlets for more than one system/voltage are grouped.
- .2 Stamped galvanized steel outlet boxes with concealed wiring, only when approved by the Engineer.
- .3 Cast zinc-electroplated malleable iron or cast aluminum metallic outlet boxes with rigid metallic conduit, except EMT, for surface mounted indoors/outdoors, flush-mounted in masonry walls, and hazardous areas connected with explosion-proof wiring.
- .4 PVC plastic outlet boxes with rigid non-metallic conduit, for surface mounted indoors/outdoors, and flush-mounted in masonry walls.

- .5 Conduit boxes where there is adequate space for cable radii, otherwise adequately sized pull boxes.

## 2.4 Splitters

- .1 Splitters (SBX) to CSA C22.2 No. 76; general purpose CSA 1 type enclosure, baked enamelled steel construction, unless otherwise indicated; welded corners and formed hinged cover, suitable for locking; with rating as indicated on the drawings and schedules.
- .2 Insulated single-pole terminals to CSA C22.2 No. 158; type, number and size as required; suitable for branch circuit copper and/or aluminum conductors, with ratings as indicated on the drawings and schedules, with minimum of three (3) spare branch terminal connections per phase, including grounding/bonding lugs.

## 2.5 Junction Boxes, Pull Boxes, and Terminal Boxes

- .1 Junction boxes (JB/JBX), pull boxes (PB/PBX), and terminal boxes (TB/TBX) to CSA C22.2 No. 40; indoor/outdoor water-tight CSA 4 type enclosure, with material construction to match wireway construction used, unless otherwise noted on the drawings, with screw-on flat cover, surface-mount or flush-mount with 25mm minimum cover extension all around, to suit installation.
- .2 Terminal blocks to CSA C22.2 No. 158, as required and/or indicated on the drawings.
  - .1 Separate three-pole power terminal blocks for each load where shown on the drawings or as required; provide suitably rated stand-off insulators for terminal box intended for the use at the voltages in excess of 1000V.
  - .2 Control terminal blocks, separate for each load, source and voltage required; with at least 10% or 4, whichever larger, spare control connection points for control cable termination.
  - .3 Size boxes to CSA C22.1, unless specified otherwise, minimum sizes of control terminal boxes: 305 x 305 x 152mm deep, power terminal boxes 610 x 610 x 203mm deep up to 1,000V, and 915 x 915 x 457mm deep over 1,000V.

## 2.6 Underground Duct Bank Markers and Accessories

- .1 CSA approved detectable RED marking tape, printed "CAUTION BURIED ELECTRIC LINE BELOW".
- .2 Pull rope suitable for ducts used and sized for the application.
- .3 Cable protection, 50mm thick concrete slab, or 38mm thick pressure treated planks, covering entire width of duct bank, as indicated on the drawings.
- .4 Concrete type cable markers: 600mm x 600mm x 100mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
- .5 Pressure treated cedar post type markers: 89mm x 89mm, 1.5m long, with aluminum anodized nameplate, 89mm x 125mm, 1.5mm, fastened near post top, on side facing cable or conduit to indicate depth and direction of duct and cable runs with words Electrical Cable, Joint or Conduit with arrows to indicate change in direction.

### **3.0 Execution**

#### **3.1 General Requirements for Underground Duct Banks**

- .1 Refer to detail drawings for duct banks locations and constructions. Install direct buried underground conduits, concrete encased underground conduits and direct buried cables to CSA C22.3 No. 7, at elevations shown and in accordance with the drawings.
- .2 For road crossing, obtain permit, and comply with municipality or road authority regulations. Use sufficient qualified personnel for rapid placing prefabricated reinforced duct sections in road crossings that are of time-restricted availability.
- .3 Locate all existing underground utilities and structures prior to construction. Hand dig or hydro-vac excavate in the vicinity of existing services as required.
- .4 Unless otherwise indicated, maintain sufficient horizontal and vertical separation as follows:
  - .1 300mm horizontal clearance from any underground utilities and piping; 150mm clearance at crossings; provide support as required.
  - .2 50mm between communication and control lines; 100mm between power lines, 190mm centre-centre; maintain vertical separation at cross-overs.
  - .3 300mm between fire alarm, communication or control lines and power lines, with fire alarm, communication and control lines in upper position.
- .5 Coordinate trench excavation and backfill with site civil / general contractor as required.
- .6 Saw cut with straight lines, all asphalt and concrete surfaces to be excavated. Remove and dispose of construction waste in accordance with general requirements.
- .7 If organic material or non-competent subgrade is encountered during excavation, remove until suitable firm material is found, as directed by Engineer. Backfill up to required depth of excavation with screened granular A material, in lifts of 150mm compacted to 95% SPD.
- .8 Place and compact native backfill material free of debris, sharp, organic, or frozen material, screened where particle sizes may exceed 26.5mm; installed in lifts of 150mm compacted to 90% SPD, 95% SPD in vehicular areas. Where native soil is not suitable for backfill, or where indicated on the drawings, supply granular 'A' material, and where required thermally controlled lime-stone screened granular material, or equivalent, with thermal resistivity not exceeding specified °C-m/W.
- .9 Restore finished surface as required. In sodden areas, supply and place 150mm of topsoil; sod or seed as indicated on the drawings. In vehicular areas, supply, place and compact granular sub-base / base / surface material to match existing conditions or new design requirements.
- .10 Provide warning tape at approximately 50% depth below finished grade, for the entire length and width of the underground raceway.
- .11 Where required or indicated on the drawings, provide underground raceway markers, placed as specified along underground raceway run and in any direction change.

#### **3.2 Underground Conduits**

- .1 Install direct buried or concrete encased conduits in trenches to depth as indicated on the drawings.
- .2 Use mitre box to field cut conduit where required to ensure a square cut. Where required, chamfer inside of all conduit ends, 2.5 mm at 15°, remove burrs and break outside edge.

- .3 Stagger joints in adjacent layers at least 150mm. Ensure full insertion of conduit at joints. Apply approved PVC solvent cement and permit it to set to manufacturer recommendations. Solvent cementing shall not be attempted in the rain.
- .4 Complete entire conduit lengths where possible prior to backfilling or concrete encasement.
- .5 Clean and proof conduits before setting in place.
  - .1 Immediately after placing of concrete and before it is set, or before backfilling direct buried conduits, pull through each conduit a stiff bristle brush to remove sand, earth and other foreign matter.
  - .2 Pull through a wooden round-end cylindrical mandrel, not less than 300mm long and 6mm less in diameter than internal diameter of duct.
  - .3 Prove that each conduit has not collapsed or that any joint has come apart.
  - .4 If failure is evidenced by the presence of concrete or water in any conduit or the inability to pull mandrill through, immediately remove the concrete or backfill and replace failed conduit sections fully.
- .6 Cap ends of conduits during construction and after installation to prevent entrance of foreign materials.
- .7 Excavate minimum 50mm below required trench depth. Place and firmly compact bedding of native or imported screened material, with granules not exceeding 9.5mm, up to required trench depth.
- .8 After each **direct buried conduit** tier is installed, place and firmly compact initial backfill of native or imported screened material, with granules not exceeding 9.5mm, minimum 50mm above top conduit tier. Where indicated on the drawings, supply thermally controlled lime-stone screened sand material, or equivalent, with thermal resistivity in °C-m/W as specified.

### 3.3 Above Ground Conduits

- .1 Install conduits as indicated on the drawings, and unless otherwise indicated, install rigid aluminum conduit for outdoor areas; rigid PVC conduit indoors, and for underground or concrete encased installations; flexible non-metallic tubing for installation in concrete slabs; and flexible metallic or non-metallic liquid-tight conduit, to match rigid conduit connecting to, for connection to surface or recessed fluorescent fixtures, unit heaters, motors, actuators, and other vibrating equipment.
- .2 Unless otherwise specified, size conduit to CSA C22.1 plus 50% for future use, with minimum conduit size for lighting, power and control circuits 19mm.
- .3 Support conduit with maximum spacing to CSA C22.1; for horizontally installed PVC conduit, maximum spacing not to exceed 50% of specified.
- .4 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .5 Install conduits parallel and perpendicular to building lines and provide a small slope for drainage.
- .6 Surface mount conduits in process areas.
  - .1 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
  - .2 Run conduits in flanged portion of structural steel.
  - .3 Group conduits wherever possible on suspended or surface channels.
  - .4 Do not pass conduits through structural members.
  - .5 Do not locate conduits less than 100mm parallel to or below steam or hot water lines with minimum of 50mm at crossovers.

- .6 Install nylon spacers / isolation pads between aluminum conduit fasteners and supports such that they do not come in contact with masonry surfaces.
- .7 All male threads on PVC conduit and all female threads on conduit couplings shall be protected by a coating of red polyurethane.
- .7 Do not encircle PVC conduits with ferrous metal so that a magnetic path maybe induced, including rebar, ties, clamps, etc.
- .8 Install conduit-sealing fittings in conduits as required at transition from heated to unheated areas and locate in heated area. Fill with non-hardening compound made by same manufacturer as the fitting.
- .9 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .10 Field threads on rigid conduit must be of sufficient length to draw conduits up tight. Use pipe compound on threads.
- .11 Deburr all conduits, both ends, and repair coatings.
- .12 Install fish cord in empty conduits.
- .13 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.

### **3.4 Outlet and Conduit Boxes**

- .1 Provide outlet boxes for each lighting fixture, wiring device, telephone outlet, fire alarm system component, communications systems component, and each other such outlet. Provide conduit boxes as required.
- .2 Support outlet boxes independently of connecting conduits.
- .3 Provide nylon spacer / isolating pad between all aluminum materials and masonry.
- .4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections without use of reducing washers.
- .5 For flush mounting devices, provide approved boxes with extension and concrete rings for devices in concrete slabs and walls; extension and plaster rings for devices in finished plaster or tile walls.
- .6 Provide knock-out fillers to prevent entry of debris. Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction; remove upon completion of work.
- .7 Provide bushing and connectors with nylon insulated throats; double clamps for non-metallic sheathed cables; double locknuts and insulated bushings on sheet metal boxes.
- .8 Provide threaded hub type connectors and O-rings at boxes where water or corrosive atmosphere may be present indoors, and outdoors; "back-to-back" locknut connection of conduit to box is not acceptable.
- .9 Generally, mounting heights and locations for outlets are indicated on the drawings, however, confirm the exact location and arrangement of all outlets prior to roughing-in. Architectural drawings and the Engineer's instructions have precedence over electrical drawing.
- .10 Do not install outlet boxes "back-to-back" in walls and partitions. Stagger such outlets a minimum of 150 mm, pack the partition space between and around the boxes with acoustic insulation, and caulk around the perimeter of each box with acoustic caulking, all to the approval of the Engineer, "Thru-wall" type boxes will not be permitted for any application.

- .11 Provide blank cover plates over all boxes left empty for future installation and existing obsolete boxes which are to remain in position. Clearly identify each box as to its intended use to Engineer's approval. Generally, blank cover plates are to match other device plates in the area.

### **3.5 Splitter Boxes**

- .1 Install splitters where shown on the drawings. Mount plumb, true and square to the building lines. Extend splitters full length of equipment arrangement except where indicated otherwise.

### **3.6 Junction Boxes, Pull Boxes and Terminal Boxes**

- .1 Install pull boxes, junction boxes and terminal boxes in conduit systems wherever shown on the drawings, and/or wherever necessary to facilitate conductor installations. Install boxes in inconspicuous but accessible locations.
- .2 Generally, only main junction and pull boxes are indicated on the drawings and/or schedules; provide pull boxes at a convenient and suitable intermediate and accessible locations for conduit runs exceeding 30m in length, or with more than three 90° bends.
- .3 Accurately locate and identify all concealed and visible pull boxes and junction boxes on record drawings.
- .4 Provide bonding for terminal boxes as required.

### **3.7 Raceway and Boxes Identification**

- .1 Unless specified otherwise, provide thermal transfer laser printed labels for conduit and cable tray identification, sufficiently large to clearly identify the conduit or cable tray from the ground level. Place labels outside of the entry to all enclosures, where penetrating through separations (both sides), and in at least one central location in any area / room.
- .2 Unless specified otherwise, provide thermal transfer laser printed labels for junction boxes, pull boxes, terminal boxes and splitter boxes identification, sufficiently large to clearly identify the tag, voltage, power source and destination of control signals as identified on the drawings and schedules.
- .3 Unless otherwise specified, labels to be black text on white background.

**End of Section**

## 16120 Wires and Cables

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for electrical cables and wiring.
- .2 Provide all required cables as indicated on the drawings and schedules; including all necessary cables, not specifically indicated, for complete and working system.
- .3 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No.38 / UL 44 - Thermoset-insulated wires and cables
- .2 CSA C22.2 No. 75 / UL 83 - Thermoplastic insulated wires and cables
- .3 CSA C22.2 No.127 - Equipment and Lead Wires
- .4 CSA C22.2 No.131 - Type TECK 90 Cable
- .5 CSA C22.2 No. 214/ UL 444 - Communications Cables
- .6 CSA C22.2 No. 230 - Tray Cables
- .7 CSA C22.2 No. 233 - Cords and Cord Sets for Communication Systems
- .8 CSA C22.2 No. 239 - Control and Instrumentation Cables
- .9 CSA C22.2 No. 174 - Cables and Cable Glands for Use in Hazardous Locations
- .10 CSA C22.2 No. 65 - Wire Connectors
- .11 CSA C22.2 No. 0.3 - Test methods for electrical wires and cables
- .12 CSA C22.2 No. 198.1 - Extruded Insulating Tubing
- .13 CSA C22.2 No. 198.2 - Sealed Wire Connector Systems
- .14 CSA C22.2 No. 198.3 - Coated Electrical Sleeving

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.
  - .1 Include product data sheet for each type of cable, cable termination, fittings and accessories.

#### 1.4 Equipment and Materials

- .1 All conductors to be stranded, sizes and material as indicated; minimum #6AWG for medium voltage power cables, #12AWG for low voltage power cables, #14AWG control cables, #18AWG instrumentation cables.
- .2 Unless otherwise indicated, every cable run from a source to a load is to include an appropriately sized separate bonding conductor.

- .3 The following cable designations are used within the specifications and drawings:
  - .1 All cables designated as “n#” refers to “n” single conductor cables plus bonding conductor;
  - .2 All cables designated as “nC” refers to “n-conductor” cable with integral bonding conductor;
  - .3 All cables designated as “nP” refers to cable with “n” twisted pairs plus shield; and
  - .4 All cables designated as “nT” refers to cable with “n” twisted triads plus shield.

## 2.0 Products

### 2.1 Low Voltage Power and Control Cables

- .1 Armoured Cables TECK90 to CSA C22.2 No. 131, including CSA C22.2 No. 174; single or multiple copper (Cu) or aluminum (Al) conductors; RW90 1000V rated conductor insulation, 600V for smaller size and control cables; bare copper bonding wire; PVC inner jacket; aluminum interlocking armour; PVC outer jacket; suitable for installation in hazardous locations (HL) where required.
- .2 Tray Cables (TC) to CSA C22.2 No. 230; multiple copper (Cu) conductors; RW90 1000V conductor insulation, 600V for smaller size cables as required; bare copper bonding wire; PVC inner jacket; aluminum interlocking armour; PVC outer jacket; suitable for installation in hazardous locations (HL) where required.
  - .1 For all VFDs provide VFD rated cable as indicated on the drawings including dual spiral copper tape shield, and three (3) separate bonding conductors.
- .3 Thermoset Insulated Wires and Cables to CSA C22.2 No. 38 / UL 44; single copper (Cu) or aluminum (Al) conductor; RW90 600V / RWU90 1000V conductor insulation.
- .4 Thermoplastic Insulated Wires and Cables to CSA C22.2 No. 75 / UL 83; single copper (Cu) or aluminum (Al) conductor; TW75 75°C dry or T90 / TWN75 90°C (dry) / 75°C (wet) 600V conductor insulation, with nylon covering (T90).

### 2.2 Control and Instrumentation Cables

- .1 Armoured Control and Instrumentation Cable ACIC to CSA C22.2 No.239, including CSA C22.2 No. 174; single or multiple stranded tinned-copper (Cu) conductors, pairs or triads; PVC 105°C (dry) / 75°C (wet) 300V instrumentation conductor insulation, RW90 300V control conductor insulation, 600V where required; shielding of aluminum foil-polyester tape for 100% coverage over each pair/triad and over all conductors; bare copper bonding wire; PVC inner jacket; interlocking aluminum armour; PVC outer jacket; suitable for installation in hazardous locations (HL) where required.
- .2 Control and Instrumentation Cable CIC to CSA C22.2 No. 239, single or multiple stranded tinned copper (Cu) conductors; PVC 105°C (dry) / 75°C (wet) 300V instrumentation conductor insulation, RW90 300V control conductor insulation, 600V rated where required; shielding of aluminum foil-polyester tape for 100% coverage over each pair/triad and over all conductors; PVC outer jacket.
- .3 Switchboard Cable to CSA C22.2 No. 38 / UL 44; multiple stranded tinned-copper single-conductor; SIS 90°C 600V conductor insulation.
- .4 Thermoplastic Equipment Wire to CSA C22.2 No. 127; multiple stranded tinned-copper (Cu) single-conductor; TEW 105°C 600V conductor insulation.

### **2.3 Ethernet Communication Cables**

- .1 Ethernet cables to C22.2 NO. 214/ UL 44, Category 6A, 4 bonded pairs, #23AWG or #24AWG with PVC insulated, colour-coded, solid copper conductors, FT4 to suit site conditions, meeting the physical and electrical characteristics for category, with 600V rated insulation and overall shielding where indicated, with metallic or non-metallic interlocking armour with blue PVC jacket where indicated. EtherNet/IP compliant. All RJ45 terminations are to be metal body by Belden.

### **2.4 Low Voltage Cable Terminations and Fitting**

- .1 Cable termination and fittings to CSA C22.2 No.18.3, including CSA C22.2 No. 174.
- .2 Aluminum or stainless steel watertight fittings c/w O-ring, CSA listed and approved for TC, TECK or ACIC cables, explosion-proof as required for hazardous areas, and with grounding bushing for end not terminating at approved bonding materials.
- .3 Watertight, oil-tight, bushing stress-relief fittings for non-armoured cables, service entrance as required.
- .4 Cold shrink sleeve termination for instrumentation and control cable insulation jacket.

### **2.5 Cable Splices**

- .1 Cable splices to CSA C22.2 No. 198.2 for low voltage splices, or to IEEE Std. 404 for high voltage splices; cold shrink splice kit, manufactured by 3M or approved equal.

### **2.6 Conductor and Wire Connectors**

- .1 Conductor and wire connectors to CSA C22.2 No.65.
- .2 Fixture type splicing connectors for low voltage power conductors #10AWG and smaller; insulated butt-splices, insulated set-screw connector, or tapped splice cap & crimp connector; tin-plated suitable for copper and/or aluminum conductors; and for voltage applied. Wire nut connectors are not acceptable.
- .3 Compression type wire connectors for larger size low voltage and all medium voltage power conductors not terminating at equipment lugs/terminals or mechanical lugs, tin-plated suitable for copper and/or aluminum conductors, and for voltage applied; size as required; 90°C rated; with standard NEMA bolt hole spacing, 2-hole for larger size conductors and distribution centre/transformer feeders.
- .4 Pressure type wire connectors and terminals for control and instrumentation conductors not terminating at the approved terminal block, or where specified; insulated 300V rated, 600V where required, size as required; fork or ring type to suit application; tin-plated suitable for copper conductors.

### **2.7 Motor Lead Splices**

- .1 Motor leads pigtail connectors, CSA certified, compression type wire connector, NEMA 1-hole for low voltage cables up to #1AWG and NEMA 2-hole for medium voltage cables and low voltage cables #1/0AWG and larger, suitable for voltage and cable type/size, c/w thermoplastic elastomer insulating boots and sealing compound.
- .2 Where specified, quick connect/disconnect pressure type wire connectors with quick connect/disconnect capabilities; tin-plated copper; 600V, 90°C rated; size as required; c/w thermoplastic elastomer insulating boots and sealing compound, T&B series MD or approved equal.

### **3.0 Execution**

#### **3.1 Direct Buried Cables**

- .1 Install direct buried cables in trenches to the depth as indicated on the drawings, with protection for vehicular traffic where required. Install multiple cables in trench simultaneously. Install multiple layers of cables tier-by-tier.
- .2 Where cable splices are required, and approved by the Engineer, make splices and terminations by qualified and experienced journeyman in accordance with manufacturer's instructions using approved splicing kits. Leave 600mm of surplus cable in each direction where possible. Unless splices are located in the readily accessible location, provide above ground concrete marker identifying splice location (depth), and cable type / voltage.
- .3 Allow for minimum permitted radius at cable bends for low voltage non-armoured cable 8 times diameter of cable; for metallic armoured cables and medium voltage cables 12 times diameter of cables; or in accordance with manufacturer's instructions and to CSA C22.1.
- .4 Supply, place and compact screened sand bedding, with granules not exceeding 4.75mm, installed minimum 75mm below and above cables. Where indicated on the drawings, supply thermally controlled lime-stone screened sand material, or equivalent, with thermal resistivity in °C-m/W as specified.
- .5 Where indicated on the drawings, provide cable protection laid on minimum 150mm granular 'A' bedding compacted to 95% SPD.
- .6 For cables without internal bonding conductor, provide an insulated bonding conductor for each group of cables; sized to CSA C22.1 unless otherwise indicated.

#### **3.2 Cables in Underground Ducts**

- .1 Install cables in ducts without splices. Install multiple cables in duct simultaneously.
- .2 Copiously lubricate duct immediately prior to pulling in the cables. Lubrication from prior attempts to install cable shall be removed. Use CSA approved lubricants of type compatible with cable jacket.
- .3 Before pulling cable into ducts and until cables are properly terminated, seal ends of cables with moisture-resistant seal tape.
- .4 After installation of cables, seal duct ends with duct sealing compound.
- .5 Leave pulling rope in all ducts.
- .6 For cables without internal bonding conductor, provide an insulated bonding conductor in each duct; sized to CSA C22.1 unless otherwise indicated.

#### **3.3 Cables in Conduits**

- .1 Install cables in conduits without splices. Install multiple cables in conduit simultaneously.
- .2 Where required, lubricate duct immediately prior to pulling in the cables. Lubrication from prior attempts to install cable shall be removed. Use CSA approved lubricants of type compatible with cable jacket.
- .3 Leave pulling rope in all conduits.
- .4 For cables without internal bonding conductor, provide an insulated bonding conductor in each conduit; sized to CSA C22.1 unless otherwise indicated.

### 3.4 Cable and Conductor Termination

- .1 Remove insulation and armour/sheath carefully from both ends of conductors.
- .2 Terminate armoured cables with approved cable fittings to manufacturer specification. Bond and ground as required.
- .3 Terminate service entrance cables and thermoset insulated cables with approved bushing stress-relief fittings to manufacturer specification.
- .4 Terminate instrumentation and control cable insulation jacket with cold shrink sleeve. Bond and ground drain wire/shield as required.
- .5 Terminate medium voltage cables with insulation shields using stress cones and terminations in accordance with manufacturer's instructions. Bond and ground as required.
- .6 Apply coat of zinc joint compound on all conductors prior to installation of connectors. Terminate all conductors connecting to equipment without lugs or terminal blocks with specified cable connectors.
- .7 Connect and tighten conductors. Connect to ground and tighten cable shields and bonding conductors as required and/or indicated on the drawings.

### 3.5 Cable and Conductor Identification

- .1 Provide conductor colour coding and identification to CSA C22.1.
- .2 Unless specified otherwise, provide thermal transfer laser printed labels for individual conductor and cable identification, sufficiently large to clearly identify conductor and cable. Unless otherwise specified, labels to be multi-line repetitive black text on white background, with clear protective end, containing conductor/cable tag as identified on the drawings and schedules.
  - .1 Place cables labels outside of the entry to all enclosures, were penetrating through separations (both sides), and where entering or leaving raceways.
  - .2 Place conductor's labels within the equipment at all terminal and junction points.
- .3 Maintain phase sequence and colour coding throughout. Unless power conductor insulation is colour coded to CSA C22.1, provide color coded phasing tape at each termination as follows:
  - .1 1-phase / 2-wire DC or AC system: red (positive) / black or yellow (negative), or black or yellow (line) / white (neutral);
  - .2 1-phase / 3-wire DC or AC system: red (positive line - hot) / black or yellow (negative line - hot) / white (positive neutral - return) / white or grey (negative neutral - return), or black (line 1) / red (line 2) / white (neutral); and
  - .3 3-phase / 3 or 4-wire AC system: red (phase A) / black or yellow (phase B) / blue (phase C) / white (neutral).
- .4 Control conductors shall be colour coded as follows:
  - .1 AC Control: Red (local power source), Yellow (external power source), White (neutral);
  - .2 DC Control: Blue (positive), White/Blue Striped (negative);
  - .3 Equipment Grounding: Green;
  - .4 Isolated Ground: Green/Yellow Striped;
  - .5 Interlock Control Circuit: Yellow.

### **3.6 Field Quality Control, Start-up and Commissioning**

- .1 Perform field quality control, start-up and commissioning in accordance with Section 16030 Commissioning of Electrical System.
  - .1 Remove and replace entire length of cable if cable fails to meet any of test criteria.
  - .2 Damage to the outer jacket shall be repaired by heat-shrink tubing with factory-applied adhesive, to form a gas impenetrable seal. If the cable cannot be sealed, it shall be replaced in its entirety. Heat-shrink colour shall match cable jacket colour.

**End of Section**

## 16160 Grounding and Bonding

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for electrical system grounding and equipment bonding.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.1 - Canadian Electrical Code, Part 1, with Ontario Amendments (Ontario Electrical Safety Code)
- .2 CSA C22.2 No. 0.4 - Bonding and Grounding of Electrical Equipment (Protective Grounding)
- .3 CSA C22.2 No. 41 - Grounding and Bonding Equipment
- .4 ANSI/IEEE 837 - Qualifying Permanent Connections Used in Substation Grounding

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.
  - .1 Include product data sheet for each type of wire, conductor, termination, fittings and accessories.

### 2.0 Products

#### 2.1 Materials

- .1 Rod electrodes: copper-clad steel, 19 $\emptyset$ , 3m long.
- .2 Plates electrodes: galvanized steel or copper plate, minimum 0.2m<sup>2</sup> contact surface area.
- .3 Plate electrodes: galvanized steel, minimum surface area 0.2m<sup>2</sup>, 6mm thick.
- .4 Copper bare conductor, minimum 2/0AWG, for buried ground grid and ground bus, and electrode interconnections.
- .5 RW90 green insulated copper conductor, sized in accordance with CSA C22.1, for system grounding and equipment bonding connections.
- .6 Tinned copper bare conductor, minimum 2/0AWG, for bonding of ground bus, metal structures, gradient control mats, transformers, switchgear, switchboard, MCC, panelboards, motors frames, etc.
- .7 Tinned copper bare conductor, sized in accordance with CSA C22.1, minimum 2/0AWG, for continuous cable tray bonding.
- .8 RW90 green insulated copper conductor, minimum 6AWG, for grounding cable sheaths, raceways, pipe work, screen guards, and voltage transformers.

- .9 RW90 green insulated copper conductor, minimum 10AWG, for grounding meter, relay cases, and ground rod test system.
- .10 Extra flexible tinned copper braid conductor, minimum 2/0AWG equivalent size, for connection of switch mechanism operating rod to gradient control mat, fence gates, vault doors, and electrical room doors and windows.
- .11 Ground bus: tin-plated copper, 50.8 x 6.35mm (2" x 1/4") minimum size, complete with insulated supports, fastenings and connectors.
- .12 Bolted removable test links for connection to ground of any building non-current carrying metal surfaces and distribution centres neutral buses.
- .13 Gradient control mat: galvanized steel, minimum size 1.83 x 1.22m (6' x 4'), 152 x 152mm (6" x 6") mesh and 6.35mm (1/4") thick.
- .14 Compression connectors, ANSI/IEEE and CUL/CSA approved, non-corrosive, high strength, BURNDY HYGROUND irreversible compression system, or approved equal:
  - .1 Compression grounding taps and connectors (YGHP-C, YGHR-C, YGHC-C, YGL-C/YGLR-C) for connection of under-ground grounding conductor to rod electrode or other grounding conductor. Where approved by the Engineer, exothermic copper welding connectors for under-ground installation.
  - .2 Compression grounding connector (YGIB) c/w 2-hole compression terminal (YGHA) for connection of bonding/grounding conductor to the building structural steel members above ground. Where approved by the Engineer, welding grounding stud connector (GSTUD-HY) c/w compression grounding connector YGHP-C for connection of bonding/grounding conductor to the building structural steel members above ground.
  - .3 Compression grounding plates (YGF-2N/4N) for connection of bonding/grounding conductor to the building structural steel members direct buried or encased in concrete.
- .15 Mechanical connectors, UL/CSA approved, non-corrosive, high strength, BURNDY "G" series, or approved equal, for connection of bonding/grounding conductor to cable tray, and U-bolt clamp connector for connection of bonding/grounding conductor to electrical raceways, metallic piping, fence, posts, etc.
- .16 Accessories: non-corroding, necessary for complete grounding system, type, size material as required, including but not limited to: grounding and bonding bushings, protective type clamps, buriable compression connectors, bonding jumpers, straps, pressure wire connectors, etc.
- .17 Armoured cable sheath isolating plates, non-conducting fibre 12mm thick, or non-magnetic aluminum 10mm thick.

### **3.0 Execution**

#### **3.1 General Installation**

- .1 Install complete continuous grounding system including, electrodes, conductors, connectors and accessories in accordance with CSA C22.2 No. 0.4, No. 41, and the drawings.
- .2 Protect exposed grounding conductors from mechanical injury with PVC conduit at ground level or where penetrating concrete. Provide additional mechanical protection where required.

- .3 Make buried connections and connections to electrodes, structural steel work, using permanent, buriable, irreversible compression connectors to ANSI/IEEE 837.
- .4 Exothermic copper welding process is only permitted under the direct and immediate supervision of the manufacturer's representative, or demonstrable expertise acceptable to the Engineer.
- .5 Use mechanical connectors for grounding/bonding connections to equipment provided with lugs.
- .6 Use tinned copper conductors for aluminum structures.
- .7 Do not use bare copper conductors near un-jacketed lead sheath cables.
- .8 Make grounding connections in radial configuration only, with connections terminating at single grounding point at the line end of the circuit.
- .9 Install connectors in accordance with manufacturer's instructions.

### **3.2 Ground Grid and Electrodes**

- .1 Install ground rod electrodes 300mm below finished grade; install plate electrodes 600mm below finished grade. Unless otherwise indicated:
- .2 Install horizontal ground grid, 300mm below finished grade, by interconnecting all ground electrodes. Unless otherwise indicated provide grid 1m offset about generators.
- .3 Where indicated on the drawings, install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Contractor shall make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails, or space is limited.

### **3.3 Grounding Bus**

- .1 Install copper grounding bus mounted on insulated supports on wall of electrical rooms.
- .2 Ground items of electrical equipment in electrical room to ground bus with individual bare stranded tinned copper conductors.

### **3.4 System and Circuit Grounding**

- .1 Install system and circuit grounding connections to neutral of all power and distribution transformers, and generators, as indicated on the drawings.
- .2 Connect transformer neutral and distribution neutral together using full system voltage rated insulated conductors to one side of ground test link, the other side of the test link being connected directly to main station/system ground.
- .3 Ensure neutrals of voltage transformers are bonded directly to their respective transformer neutral and not to main station/system ground.
- .4 Provide grounding conductors of size and quantity in accordance with CSA C22.1, unless modified otherwise on the drawings.

### **3.5 Equipment Bonding**

- .1 Install bonding connections as indicated on the drawings, and including but not limited to metallic water mains, sky wires, neutrals gradient control mats; non-current carrying metal parts of transformers, generators, motors, circuit breakers, reclosers, current/voltage transformers, frames of gang-operated switches and fuse cut-out bases, switchgear, switchboards, panelboards; cable-sheaths, raceways, pipe work, screen guards; meter and

relay cases; any exposed building metal within or forming part of station enclosure or electrical room, rebar and building steel; sub-station fences, pothead bodies; outdoor lighting; elevators and escalators, etc.

- .2 Provide bonding conductors of size and quantity in accordance with CSA C22.1, unless modified otherwise on the drawings.
- .3 Provide bonding conductor within any non-metallic raceway, or metallic raceway not suitable for bonding.
- .4 Connect metallic piping and ventilation ductwork (water, oil, air, etc.) to main ground bus at several locations, preferably inside station or electrical rooms, including each service location within station.
- .5 Connect grounding grid in two (2) locations to equipment grounding bus located in the electrical rooms, main service transformer, generator enclosure, and any medium and high voltage equipment non-current carrying metal parts.
- .6 Connect room hinged doors to main ground with flexible jumper.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

### **3.6 Cable Sheath Grounding / Bonding**

- .1 Use approved cable and conduit connectors to terminate cables c/w grounding bushings.
- .2 Bond multi-conductor metallic sheathed cables at each end.
- .3 Bond single-conductor metallic sheathed cables 425A or less, together at each end; over 425A together at one end only (line end). Use aluminum board for eddy current prevention at each end. Break sheath continuity at load end by using sheath insulating sleeves or non-conducting fibre-board for cables over 425A.
- .4 Connect bonded cables to ground.

### **3.7 Communication Systems**

- .1 Provide grounding / bonding connections for telephone, sound, fire alarm, intercommunication systems.
- .2 Make telephone grounding system in accordance with local telephone company's requirements.

### **3.8 Field Quality Control**

- .1 Before energizing electrical system perform grounding system resistance tests using method appropriate to site conditions, to approval of the Engineer and local authority having jurisdiction. Perform separate tests where system grounding and building grounding systems are not connected together, and connected together.
- .2 Perform grounding and bonding continuity tests.

**End of Section**

## 16222 Motors

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes general specifications for products, criteria and characteristics, methods and execution for low voltage electrical motors.
- .2 For common criteria see Section 16000 Common Work for Electrical.
- .3 For specific requirements see related sections in Division 11, 13, and/or 15 where motors are specified as a part of process or building equipment supply and installation.

#### 1.2 Standards

- .1 CSA C22.2 No. 14 - Industrial Control Equipment
- .2 CSA C22.2 No. 77 Motors with Inherent Overheating Protection
- .3 CSA C22.2 No. 100 Motors and Generators
- .4 CSA C22.2 No. 145 UL 674 Electric motors and generators for use in hazardous (classified) locations
- .5 CSA C390 Energy Efficient Test Methods for Three Phase Induction Motors
- .6 UL 508 - Standard for Industrial Control Equipment
- .7 UL 1004-1 Rotating Electrical Machines - General Requirements
- .8 UL-1004-2 Impedance Protected Motor
- .9 UL-1004-3 Thermally Protected Motors
- .10 UL-1004-8 Inverter Duty Motors
- .11 NEMA MG1 Motors and Generators
- .12 IEEE 112 Polyphase Induction Motors and Generators - Testing
- .13 IEEE 114 Single Phase Induction Motors - Testing

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.
  - .1 Overall dimensions of motor, actuator, gearbox.
  - .2 Shaft centreline to base dimension, shaft extension diameter and keyway, coupling dimensions and details.
  - .3 Fixing support dimensions.
  - .4 Terminal box location and size of terminals.
  - .5 Arrangement and dimensions of accessories.
  - .6 Diagram of connections, including actuator schematic diagrams.
  - .7 Motor performance chart exhibiting curves for motor torque, current, power factor, input/output kW and efficiency, including data on motor starting and no-load characteristics.

- .8 Motor speed-current and speed-torque characteristic.
- .9 Nameplate drawing and/or data.
- .10 Weight.
- .11 Installation data.

## 2.0 Products

### 2.1 Motors – General Requirements

- .1 CSA / NEMA squirrel-cage induction motors suitable for continuous operation at any point on the performance curve without exceeding the nameplate rating of the motor.
- .2 Unless specified otherwise, provide all motors with:
  - .1 Frame: cast iron, steel, or cast aluminum.
  - .2 Endplates: cast iron or cast aluminum.
  - .3 Terminal boxes: cast iron, steel, or cast aluminum.
  - .4 Corrosion resistant cast metal fan blades and shrouds for fan-cooled motors.
  - .5 Hardware: stainless steel.
  - .6 Windings: Copper with non-hygroscopic insulation.
- .3 Vendor of driven equipment shall provide motors as indicated in Division 11 and 15, on the drawings and/or schedules, and unless indicated otherwise, the ratings and characteristics as indicated herein.

<b>Location</b>	Indoor / Outdoor / Submersible
<b>Ambient Temperature</b>	<40°C
<b>Altitude</b>	<1,000m
<b>Nominal Voltage</b>	575V / 3ph for sizes ½ HP and above;
<b>Frequency</b>	60Hz
<b>Synchronous Speed</b>	As required, minimum 1,800rpm
<b>Service Factor</b>	1.15 SF max for general-purpose motors; 1.00 SF max for inverter-fed motors;
<b>Insulation Class / Temperature Rise</b>	Class H / F: inverter-fed motors;
<b>Insulation Raring</b>	2,200V/0.1µs for 600V or less inverter-fed motors;
<b>Acceptable Manufacturers</b>	ABB/Baldor, Alstom, GE, Hitachi, Nidec, Siemens, TECO/Westinghouse, Toshiba, U.S. Motors, WEG

- .4 NEMA design B, starting letter G unless otherwise specified/required, capable of withstanding full-voltage starting regardless of starting method used.
  - .1 Where full-voltage starting method is used, the motor to be capable of starting the load with 80% of nominal nameplate voltage, without exceeding motor “cold” and “hot” damage characteristic.
  - .2 Where reduced-voltage method is used, the motor to be capable of starting the load with current limited to 300% of full load nameplate current, without exceeding motor “cold” and “hot” damage characteristic.
  - .3 Where variable frequency drive starting/control method is used, motors shall be NEMA inverter duty, down to 10:1 turn down ratio to satisfy minimum load conditions without de-rating, and without exceeding motor “cold” and “hot” damage

characteristic during starting with minimum 20s “ramp” start for variable torque applications. For constant torque applications, including chemical feed/metering pumps, inverter duty down to 100:1 turn down ratio.

- .5 Motor Enclosure:
  - .1 Totally enclosed fan cooled (TEFC), totally enclosed explosion proof (XPFC) for use in hazardous areas as indicated, with appropriately rated power cable terminal box.
  - .2 Submersible or dry-pit submersible, integral to the driven equipment (pumps), with factory sealed waterproof cable entry gland, and individual or composite cable(s) suitable for 600Vac power and 24Vdc or 120Vac control requirements of the pumps and associated monitoring panels. If composite cable is used, control conductors shall be shielded; non-shielded composite cable will not be accepted.
- .6 Factory Installed Internal Protection:
  - .1 Line-connected bi-metal switch, one in each phase, for thermal protection of all fractional HP 3-phase 575V rated motors provided without external overload protection.
  - .2 For submersible pumps, or where required to maintain specific rating:
    - .1 All stators shall incorporate thermal switches in series to monitor the temperature of each phase winding. The thermal switches shall open at 125°C, stop the motor and activate an alarm.
    - .2 Stator-windings-embedded thermistors, one in each phase, identified and connected to terminal block in junction box mounted on the motor frame, 1,200 ohms maximum @ 25°C. Thermistors shall trip the relay at motor winding temperature not exceeding motor winding temperature classification.
    - .3 Float Leakage Sensor (FLS), a float switch shall detect the presence of water in the stator chamber. When activated, the FLS will stop the motor and activate an alarm.
    - .4 Moisture sensor in the stator cavity that will stop the pump if sufficient moisture is present in the motor chamber.
    - .5 Supervisory relays designed to monitor the temperature and moisture of submersible motor/pump, as well as to provide separate alarm dry contact for each function, SPDT, NEMA A300/P300 rated.
  - .3 Provide stator winding overtemperature protection on all motors rated 50HP and larger. Motors rated less than 50HP to have stator winding overtemperature protection when required by the specific equipment specification section, or if recommended by the driven equipment manufacturer.
    - .1 Thermostats, one (1) per phase, normally-closed, snap action, bimetallic, temperature actuated switches installed in the connection end-turns of the motor windings. The contacts shall be connected to shut down the motor upon excessive winding temperatures. Thermostats shall automatically reset. Leads shall be brought out to the main conduit box.
    - .2 Thermistors, one (1) per phase, for winding running and locked rotor overtemperature protection. One detector to be provided per phase. Detectors to be positive thermal protection (PTC) thermistor type, with leads brought out to a terminal strip in a NEMA 4X enclosure, or a NEMA 7 enclosure (hazardous locations). Where a control module is required for the thermistors, it shall be provided loose with the motor for installation at the motor starter.

- .7 Motor Termination Box
  - .1 Motor terminal boxes shall be gasketed, diagonally split, gasketed, cast metal NEMA 4X terminal boxes complete with threaded hub for conduit entry for ODP, TEFC, and WPI/WPII motors and oversized, diagonally split, gasketed NEMA 7 (indoors) or NEMA 8 (outdoor) terminal boxes complete with threaded hub for conduit entry for explosion-proof motors.
  - .2 Conductors in terminal boxes will be connected to compression connectors, to be suitable for wire sizes ranging between 100% and 200% motor ampacity, using 75°C wire rating for reference ampacity.
- .8 Shaft Grounding Rings
  - .1 All motors operated on variable frequency drives shall be equipped with a maintenance-free, conductive microfiber shaft grounding ring (SGR) to meet NEMA MG-1, 3.4.4.4.3 requirements, with a minimum of two rows of circumferential microfibers to discharge damaging shaft voltages away from the bearings to ground.
  - .2 SGR Service Life: Designed to last for service life of motor. Provide AEGIS SGR Conductive MicroFiber Shaft Grounding Ring or approved equal.
  - .3 Motors up to 100HP shall be provided with one shaft grounding ring installed on either the drive end or non-drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a SGR on the drive end of the motor. If line contact bearings are used in the drive end of the machine, then the line contact bearing must be electrically insulated, and the SGR installed on the opposite drive end of the motor. SGRs shall be provided and installed by the motor manufacturer and shall be installed in accordance with the SGR manufacturer's recommendations.
- .9 High-Frequency Bonding
  - .1 All motors operated on variable frequency drives shall be bonded from the motor foot to system ground with a high-frequency ground strap made of flat braided, tinned copper with terminations to accommodate motor foot and system ground connection. Provide AEGIS HF Ground Straps, or equal.
- .10 The motor antithrust bearing to be heavy-duty, type and rating to be compatible with the loads imposed by the driven equipment, sized for continuous service without overheating.
- .11 All motors and driven equipment to be statically and dynamically balanced in the shop and in the field as an assembled unit and shall be such as to produce a minimum vibration under service conditions.

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.

#### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install the motors and actuators, and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 Motors

- .1 Dry out motor if dampness present in accordance with manufacturer's instructions.
  - .2 Install motor rigid plumb and square, using only lifting facilities provided.
  - .3 Make wiring connections. Use liquid tight flexible conduit between rigid conduit and motor, metallic where metallic rigid conduit is used, non-metallic where rigid PVC conduit is used. Make flexible conduit long enough to permit movement of motor over entire length of slide rails.
  - .4 Check for correct direction of rotation, with motor uncoupled from driven equipment.
  - .5 Align and couple motor to driven machinery to manufacturer's instructions, using only correct parts such as couplings, belts, sheaves, as provided by manufacturer.
- .3 The Contractor is responsible for coordination and scheduling of such a work. Notify the Engineer in writing 5 working days prior to scheduling the visits.
  - .4 Tests shall be carried out either separately or in conjunction with other equipment tests as determined by the Engineer.
  - .5 Provide record of the start-up, commissioning and testing to the Engineer after Work is completed; a copy of the field notes before leaving the site if practical, or faxed copy within 12h, and a copy of the final typed-written record report within 48h.

### **3.3 Manufacturer's Certification and Training**

- .1 Provide manufacturer's certification and training in accordance with Section 16000 Common Work for Electrical and as modified herein.

**End of Section**

## 16414 Low Voltage Disconnect Switches

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for manual low voltage disconnect switches, fused or non-fused, enclosed equipment safety disconnect.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No. 4 / UL 98 - Enclosed Manual Air Break Switches
- .2 UL 2682 - Switch Rated Plug and Receptacle
- .3 CSA C22.2 No. 248 / UL 248 Series - Low Voltage Fuses
- .4 CSA C22.2 No. 39 - Fuseholder Assemblies

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

#### 1.4 Spare Parts and Maintenance Material

- .1 Provide spare parts and maintenance materials in accordance with Section 16000 Common Work for Electrical.
  - .1 One (1) of each control fuse for each type and size.
  - .2 Three (3) power fuses of each type and size.

### 2.0 Products

#### 2.1 Summary of Ratings and Characteristics

- .1 Provide enclosed disconnects, fused and/or unfused, and/or switch-rated plug and receptacles of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Type</b>	Enclosed non-fused or fused;
<b>Switching Poles</b>	Single-throw: 3P
<b>Voltage Rating</b>	600V for 600V 3ø/3w
<b>BIL</b>	10kV
<b>Frequency</b>	60Hz
<b>Current Rating</b>	30, 60A, 100A
<b>Short-circuit Rating</b>	10kASCR unfused, 200kASCR fused
<b>Enclosure</b>	Painted Steel, CSA 1, indoor
<b>Acceptable Manufacturers</b>	ABB, Eaton, Hubbell, Schneider, Siemens

- .2 All switches to be suitable for 100% brake and make capability of their continuous current rating, service entrance rated where required.
- .3 All switches that are part of motor branch circuits to be suitable as motor disconnects.

## **2.2 Disconnect Switches**

- .1 Heavy-duty disconnect switch, with gang-operated, quick-make quick-break mechanism, line terminal shields and visible blades.
- .2 The operating handle shall be an integral part of the enclosure base, with ON-OFF position indicated on the enclosure.
- .3 Provision for padlocking in OFF position.
- .4 Mechanically interlocked door to prevent opening when handle is in ON position, defeatable unless otherwise indicated.
- .5 Metal nameplates, front cover mounted, that contain a permanent record of switch type and rating (voltage and amperes), including CSA approval "suitable as a motor disconnecting means" (horsepower rated), where required.
- .6 Neutral bus bar for system requiring neutral, rating equal to switch rating. Ground bar for terminating bonding conductor.
- .7 One (1) internally mounted NO/NC switch auxiliary contacts, early-break/early-make, rated A300/P300, unless otherwise specified.

## **2.3 Fuses**

- .1 Where specified, provide fuses of rating, quantity and characteristic as indicated in the specification, drawings, and schedules.
  - .1 Unless otherwise indicated, provide Class J and L fuses throughout, fast acting for motor circuit protection, or time-delay for transformer or feeder protection. Alternatively, Class R or Class CC for transformer/feeder and motor circuit protection respectively.
- .2 Provide fuseholders with same rating as fuses, suitable for type and size of fuse specified without adapters.
  - .1 Where more than one load is served from the panel, provide disconnect type dead-front fuse holders, multi-pole arrangement for multi-phase loads.

## **3.0 Execution**

### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Assemble switches and provide manufacturer's quality control & factory testing in accordance with Section 16000 Common Work for Electrical.

### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install enclosed disconnects and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 Provide all necessary corrosion resistant mounting hardware as required, including stands for free standing disconnects.

- .3 Provide corrosion resistant floor supports for mounting units on the concrete floor, provide frost-free concrete footings for mounting outdoors on the native soil.
- .4 Mount disconnects as indicated on the drawings, with handles 1500 mm above finished floor, unless noted otherwise.
- .5 Wall mount disconnects where possible, otherwise provide hollow corrosion resistant post or Unistrut support for mounting of units on the common backplane.
- .6 Ship fuses separately from switches.
- .7 Ensure correct fuses fitted to physically matched mounting devices.
- .8 Install fuses before energizing circuit; face rating to be visible.

**End of Section**

## 16441 Panelboards

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for specific products, criteria, characteristics, methods and execution for panelboards.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No. 29 - Panelboards and Enclosed Panelboards
- .2 UL 67 - Panelboards
- .3 CSA C22.2 No. 5 / UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

### 2.0 Products

#### 2.1 Summary of Ratings and Characteristics

- .1 Provide distribution and/or lighting panelboards of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Voltage</b>	208Y/120V (3 $\phi$ /4w)
<b>BIL</b>	10kV
<b>Frequency</b>	60Hz
<b>Bus Current Rating</b>	100A
<b>Short-circuit Interrupting Rating</b>	10kAIR
<b>Enclosure</b>	CSA 1, indoor
<b>Service Entrance</b>	Where required
<b>Acceptable Manufacturers</b>	ABB, Eaton, Schneider, Siemens.

- .2 Panelboards to be labelled with a CSA short circuit rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the CSA series ratings including size and type of upstream device, branch devices that can be used, and CSA series short circuit rating.

## 2.2 Construction

- .1 Panelboard to be completely factory assembled with bolt-on devices, designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- .2 Panelboard trim shall cover all live parts.
  - .1 Surface trims shall be same height and width as box.
  - .2 Flush trims shall overlap the box by minimum 25mm on all sides.
  - .3 Unless otherwise specified, lighting panelboards shall have doors with concealed hinges, covering all circuit breaker handles.
    - .1 Doors shall have a semi-flush cylinder lock and catch assembly, and shall not uncover any live parts. Trim fastening screws shall not be visible.
    - .2 Provide two (2) keys for each panelboard. All locks to be keyed alike.
    - .3 Where locking devices are specified, provide adequate space so the door can be fully closed with locking device mounted on the breakers.
  - .4 Unless otherwise specified, distribution panelboard to be provided without doors.
- .3 A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door or on the trim-mount pouch.

## 2.3 Power and Ground Bus

- .1 Power bus shall be continuous, tin-plated copper, sized in accordance with applicable standards to limit temperature rise on any current carrying part.
  - .1 Each bus bar to be arranged for sequence phasing of the branch circuit devices.
  - .2 All current-carrying parts to be insulated from ground and phase-to-phase by high dielectric strength thermoplastic insulators.
  - .3 Phase bus to be pre-drilled to accommodate field installable options.
- .2 A bolted neutral bus to be included for panelboards with neutral, constructed as main bus bars, with suitable number of lugs, same rating as main bus, reduced or 200% rated where specified.
- .3 A bolted ground bus with suitable number of lugs to be included in all panels.
- .4 Where multi-section panelboards are specified, provide feed-through or sub-fed lugs as indicated.

## 2.4 Mains and Branch Circuit Devices

- .1 Main and branch circuit breakers of rating, quantity and characteristic as indicated on the drawings and/or schedules.
- .2 Where indicated provide main lugs, standard mechanical screw type, with anti-turn feature, for type and size of cables as indicated.
- .3 Thermal-magnetic molded case circuit breakers (MCCB), to CSA C22.2 No. 5 / UL 489, high dielectric strength polyester thermoset case, with gang-operated, quick-make, quick-break, mechanically trip-free switching mechanism, with non-welding high-conductive contact material and arc chutes for arc extinction, with push-to-trip test button on the front.

## 2.5 Accessories

- .1 Unless otherwise specified, provide lock-on devices for motor circuits, receptacles, fire alarm, emergency, stairway, exit and night light circuits.

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.

#### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install panelboards and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 Install circuit breakers as indicated on the drawings and schedules.
- .3 Complete circuit directory with typewritten legend showing location and load of each circuit.

**End of Section**

## 16455 Low Voltage Variable Frequency Drives

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for low voltage variable-frequency drives (VFD).
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No. 274 - Adjustable Speed Drives
- .2 UL 61800 - Standard for Adjustable Speed Electrical Power Drive Systems
- .3 NEMA ICS 7 - Adjustable Speed Drives

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

## 2.0 Products

### 2.1 Summary of Ratings and Characteristics

- .1 Provide low voltage VFDs of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Input Voltage/Frequency</b>	525-600V (3 $\phi$ ), $\pm$ 10%, 60Hz for 600V <sub>nom</sub> 3 $\phi$ system;
<b>Output Voltage/Frequency</b>	0-600V (3 $\phi$ ), 0-60Hz;
<b>Displacement Power Factor</b>	0.93-0.95 lagging @ 0-100% speed
<b>Efficiency</b>	96% @ Nominal Power
<b>Nominal Power/Overload</b>	110% Light-Overload for 60s, Variable Torque Load (VT); alternatively where indicted, 150% Heavy-Overload for 60s, Constant Torque Loads (CT)
<b>Short-circuit Rating</b>	18kASCR
<b>Rectifier</b>	6-pulse passive diode or fully gated SCR bridge
<b>Inverter</b>	PWM, IGBT bridge
<b>PWM Carrier Frequency</b>	2-8kHz
<b>Input Filter</b>	3% input line or 5% DC reactor
<b>Output Filter</b>	dV/dt filter in CSA 1 Indoor enclosure
<b>Enclosure</b>	None
<b>Acceptable Manufacturers</b>	ABB (ACS 580/880), Allen-Bradley (PowerFlex 753/755), Eaton (PowerXL DG1), Schneider (ATV630),

- .2 VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.
- .3 The drive shall be designed to operate on an AC line which may contain line notching and up to 10% harmonic distortion and minimum 1% AC line impedance (based on drive rating). An input isolation transformer shall not be required for protection from normal line transients. If line conditions dictate the use of a transformer, the K factor shall be 4.0 or less.

## 2.2 Features

- .1 Operate VFD with motor disconnected.
- .2 Programmable sensorless vector or V/Hz mode. The sensorless vector mode uses motor nameplate data plus motor operating data such as IR drop, nominal flux current and flux up time. The volts per hertz mode shall be programmed as a straight line, pre-programmed fixed boost or full custom patterns.
- .3 Programmable current limit from 20% to 250% of constant torque rating. Current limit is active for all drive states; accelerating, constant speed and decelerating. The drive employs PI regulation with an adjustable gain for smooth transition in and out of current limit.
- .4 Multi-Accel/Decel settings provide separate adjustments to allow either setting to be adjusted from 0-3000s. An adaptive current limit circuit can be disabled in programming for fast acceleration of low inertia loads.
- .5 Programmable speed regulation modes include open loop, slip compensation with 0.5% speed regulation, droop - negative slip compensation with 0.5% speed regulation, closed loop encoder feedback with 0.1% speed regulation, and process PI control.
- .6 Programming capability allows the user to produce speed profiles with linear acceleration/deceleration or "S-Curve" profiles that provide changing accel/decel rates. S-Curve profiles shall be selectable for fixed or adjustable values.
- .7 The internal process PI regulator has both proportional and integral gain adjustments as well as error inversion and output clamping functions. The feedback can be configured for normal or square root functions. If the feedback indicates that the process is moving away from the set point, the regulator will adjust the drive output until the feedback equals the reference. Process control can be enabled or disabled with a hardwire input. Transitioning in and out of process control can be tuned for faster response by preloading the integrator. Protection is provided for a loss of feedback or reference signal. A signal can also be provided to indicate that excess error exists.
- .8 The control logic is capable of "riding through" a power outage of at least 2 seconds in duration. The inverter section is shut off after a drop in bus voltage to conserve power for the drive logic. The amount of drop required will be adjustable to 50% of nominal.
- .9 The drive can respond to a loss of AC input power by adjusting the output frequency to create a regenerative situation in the motor. This regenerated energy recaptures the mechanical energy and converts it to electrical energy to power the drive logic during the power outage. This allows the drive to retain control of the motor during the power outage. Performance is based on the amount of system inertia and the length of the outage. The amount of voltage drop required to trigger inertia ride through and the level at which regulation occurs shall both be adjustable. Inertia Ride Through can be enabled or disabled via programming.
- .10 DC bus regulation is available to reduce the possibility of drive over-voltage trips due to regenerative conditions. Bus voltage is monitored and an internal regulator, triggered by a

- 15% rise in voltage, adjusts the drive's output frequency to maintain bus voltage at a nominal (100%) level. Bus regulation can be enabled or disabled via programming.
- .11 The drive shall run under selectable PWM switching frequency and upon over-temperature shall fold-back the switching frequency to reduce the operating temperature. The drive shall return to the rated switching frequency after the over-temperature condition has passed.
  - .12 The drive provides up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart. The automatic mode is not applicable to a ground fault, shorted output faults and other internal microprocessor faults. The time between restarts is adjustable from 0.5-30.0s.
  - .13 Enabled or disabled via programming, this feature allows the user to select the output current level that indicates that the load has been disconnected (broken belt / shaft / coupling) from the motor is indicated. Action is also selectable.
  - .14 Minimum of three (3) adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance are provided. The set points have an adjustable bandwidth.
  - .15 Minimum last four faults, as well as operating frequency, drive status and power mode, shall be stored at the time of fault. Information is maintained in the event of a power loss.
  - .16 Programmable class 10, 20 or 30 motor overload protection and motor stall protection. A viewable parameter stores the overload usage in percent. An alarm bit can be used to adjust a process to eliminate an overload trip.
  - .17 The drive is capable of determining the speed and direction of a spinning motor and adjusts its output to "pick-up" the motor at the rotating speed. The flying start feature is operable with or without encoder feedback.
  - .18 The digital interface is used for all set-up, operation and adjustment settings. All adjustments are stored in non-volatile memory (EEPROM). No potentiometer adjustments are used. The drive provides EEPROM memory for factory default values.

### **2.3 Analog & Discrete I/Os Interface**

- .1 Two (2) single-ended fully programmable analog inputs, jumper and/or software configurable, rating 4-20mA<sub>dc</sub> and 0-10V<sub>dc</sub> shall be provided with process control speed reference, and potentiometer speed reference programmed as a default.
- .2 Two (2) single-ended fully programmable analog outputs, jumper and/or software configurable, rated 4-20mA<sub>dc</sub> and 0-10V<sub>dc</sub>, with motor speed and current programmed as a default.
- .3 Six (6) programmable digital inputs, rated 120V<sub>ac</sub>/24V<sub>dc</sub>, powered from external control transformer or from internal power supply, with local start (2-wire), enable, external fault, two pre-set speeds, and remote/local selection programmed as a default.
- .4 Two (2) Form C relay programmable outputs, NEMA A300 / P300 rated, with running and fault status programmed as a default.
- .5 Where indicated on the drawings, Safe Torque-off input, rated 120V<sub>ac</sub>/24V<sub>dc</sub>, powered from internal power supply, minimum SIL1 certification.

### **2.4 Operator Interface**

- .1 Frequently accessed programmable parameters shall be adjustable from a "hot-swap" removable digital operator interface, multi-line, backlit LCD alphanumeric display, with status indicators and control, capable of showing drive operating conditions, fault

- indications and programming information, with use of plain language for parameters, status, and diagnostic messages.
- .2 The operator shall be able to scroll through the keypad menu to choose between monitoring, operational, parameter setup, actual parameter values, faults, fault history, and LCD contrast adjustment. Information also to indicate the standard software and optional features software loaded.
  - .3 The following set-ups and adjustments, at a minimum, shall be available:
    - .1 Start/Stop command from keypad, remote or communications port, for either 2-wire or 3-wire configuration, and maintained or pulse operation.
    - .2 Speed command from keypad, remote or communications port
    - .3 Motor direction selection
    - .4 Maximum and minimum speed limits
    - .5 Acceleration and deceleration times, two settable ranges
    - .6 Critical frequency avoidance
    - .7 Torque limit
    - .8 Multiple attempt restart function
    - .9 Multiple pre-set speeds adjustment
    - .10 Catch a spinning motor start or normal start selection
    - .11 Programmable discrete and analog I/Os
  - .4 The run, forward, reverse, stop, ready, alarm, fault, local/remote, off status indicators shall be available as a minimum.
  - .5 The following monitoring functions, at a minimum, shall be available:
    - .1 Output frequency and speed;
    - .2 Motor current, torque, power, and voltage;
    - .3 DC-link voltage;
    - .4 Heat-sink temperature;
    - .5 Operating hours/days counter;
    - .6 Operating kWh;
    - .7 Voltage and current level of analog input, digital inputs status, digital and relay outputs status; and
    - .8 Motor temperatures rise, percentage of allowable.
  - .6 Unless otherwise specified, the operator interface will be mounted at the door for enclosed units.
  - .7 Programming, trouble-shooting, diagnostic, control and monitoring functions shall also be available by using serial, Ethernet or USB port and Windows based software. The manufacturer shall supply required software at no additional cost.

## 2.5 Communications

- .1 Where indicated provide Ethernet/IP communication module integral to VFD controllers for remote control and indication via PLC/SCADA.
- .2 The communication module shall be capable of transmitting following minimum control and diagnostic data over communication network:
  - .1 Speed or frequency reference and forward/reverse run command;
  - .2 Provision for fault reset;

- .3 Statures of inputs;
- .4 Statures of protection trip and warning conditions;
- .5 Thermal capacity used;
- .6 Speed or frequency feedback; and
- .7 Instantaneous rms quantities of current, voltage and active power.

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Assemble VFD and provide manufacturer's quality control & factory testing in accordance with Section 16000 Common Work for Electrical.

#### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install enclosed VFDs and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.

**End of Section**

## 16470 Low Voltage Distribution Transformers

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for low-voltage dry-type distribution transformer mounted in standalone enclosure.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No. 47 - Air-Cooled Transformers (Dry Type)
- .2 CSA C9 - Dry-Type Transformers
- .3 UL 1561 - Dry-Type General Purpose and Power Transformers
- .4 IEEE C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

### 2.0 Products

#### 2.1 Summary of Ratings and Characteristics

- .1 Provide distribution transformers of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Type</b>	ANN, 3 $\phi$
<b>Power</b>	15kVA (3 $\phi$ )
<b>Voltage</b>	600-208Y/120V(3 $\phi$ )
<b>BIL</b>	10kV
<b>Frequency</b>	60Hz
<b>Taps</b>	4-2 ½ 2FCAN & 2FCBN
<b>Impedance</b>	2.5 – 6.5%
<b>Winding Material</b>	Copper
<b>Temperature Rise</b>	150°C, alternate 115°C or 80°C where indicated
<b>Winding Insulation</b>	1.2kV, 220°C Class
<b>Efficiency</b>	ON Reg 404/12, NRCAN 2109, US DOE 2016
<b>Enclosure</b>	CSA 1, indoor
<b>Acceptable Manufacturers</b>	Hammond, Rex, Markus

## **2.2 Construction**

- .1 Primary conduit knockout one each side, secondary conduit knockout two each side, located at bottom of enclosure.
- .2 Primary winding tap studs and terminal boards with solderless connectors.
- .3 Lifting holes, two (2) each side.
- .4 Internal neoprene, anti-vibration system under each of the mounting points of core and assembly to coil assembly of the enclosure.

## **3.0 Execution**

### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.

### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install transformers and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 Ensure adequate clearance around transformer for ventilation, minimum as per local electrical and building code.
- .3 Install transformers in level upright position. Loosen isolation pad bolts until no compression is visible. Remove shipping supports after transformer is installed.
- .4 Make primary and secondary connections in accordance with wiring diagram.

**End of Section**

## 16620 Standby Power Generation

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for engine driven standby power generator set.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA 282 - Emergency Electrical Power Supply for Buildings
- .2 B139 Series - Installation Code for Oil-burning Equipment and the 2016 TSSA Ontario Amendments
- .3 CAN/ULC-S601 - Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids
- .4 UL 142 - Sub-base Tanks
- .5 UL 1236 - Battery Chargers
- .6 UL 2200 - Stationary Engine Generator Assemblies
- .7 IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- .8 NFPA 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
- .9 NFPA 99 - Essential Electrical Systems for Health Care Facilities
- .10 NFPA 110 - Standard for Emergency and Standby Power Systems
- .11 NEMA MG1 - Motors and Generators
- .12 IEC 8528 Part 4 - Control Systems for Generator Sets
- .13 ISO 3046 - Reciprocating Internal Combustion Engines
- .14 ISO 8528 - Reciprocating internal Combustion Engine Driven Alternating Current Generating Sets

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

#### 1.4 Sequence of Operation

- .1 Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set. The generator set shall complete a time delay start period as programmed into the control.
- .2 The generator set control shall initiate the starting sequence for the generator set, including the following functions:

- .1 The control system shall verify that the engine is rotating when the starter is signalled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, indicating “fail to crank”.
- .2 The engine shall fire and accelerate as quickly as practical. If the engine does not start, it shall complete a cycle cranking process as specified. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out indicating “fail to start”.
- .3 The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over-voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
- .3 On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
- .4 When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.
- .5 Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

## 2.0 Products

### 2.1 Summary of Ratings and Characteristics

- .1 Provide generators of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Location</b>	Outdoor
<b>Ambient Temperature</b>	40°C
<b>Altitude</b>	<460m
<b>Type</b>	Natural Gas, emergency standby power (ESP)
<b>Nominal Power</b>	80kW
<b>Nominal Voltage</b>	600/347V wye
<b>Frequency</b>	60Hz
<b>Temperature Rise / Winding Insulation</b>	150°C (ESP, LTP), 125°C (PRP, COP) / 1.2kV, H Class
<b>BIL</b>	10kV
<b>Enclosure</b>	Outdoor, weather-protective, sound-attenuating
<b>Sound Attenuation</b>	75dB @ 7m
<b>Emissions Level</b>	EPA Tier 2
<b>Acceptable Manufacturers</b>	CAT, Cummins, Generac, Kohler, SDMO, Sommers

- .1 The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.

- .2 All switches, lamps, and meters in the control system shall be oil-tight and dust-tight. There shall be no exposed points in the control with the door open.
- .3 Voltage regulation shall be  $\pm 0.5\%$  for any constant load between no load and rated load for both parallel and non-parallel applications; random voltage variation with any steady load from no load to full load shall not exceed  $\pm 0.5\%$ .
- .4 Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed  $\pm 0.25\%$ .
- .5 Generator set shall be capable of single step load pick up of 100% full load, power factor, and at operating temperature.
- .6 The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the starting capability kVA at near zero power factor applied to the generator set.
- .7 The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion, 3% in any single harmonic, without 3<sup>rd</sup> order harmonics or their multiples, measured line to neutral, at full load. Telephone influence factor shall be less than 40.
- .8 The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable fuel and exhaust emission requirements at the time of commissioning.
- .9 Where multiple generators are to be operated in parallel:
  - .1 The generator set shall share real and reactive load proportionally within  $\pm 3\%$  with all other generator sets in the system.
  - .2 The time required to automatically start, accelerate to rated speed and voltage, synchronize and parallel all generator sets to the system bus on a normal power failure shall not exceed 15s.
- .10 Shall be in accordance with CSA B139-ON, Ontario installation code for oil burning equipment.

## 2.2 Engine and Equipment

- .1 The engine shall be fan cooled 4-stroke-cycle natural gas engine. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.
- .2 An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.
- .3 Skid-mounted radiator and cooling system rated for full load operation in 40°C ambient as measured at the generator air inlet, based on 0.12kPa external static pressure. Radiator shall be sized based on a core temperature which is 10°C higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50 ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.
- .4 Electric starter(s) capable of three complete cranking cycles without overheating.

- .5 Positive displacement, mechanical, full pressure, lubrication oil pump.
- .6 Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
- .7 An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
- .8 Flexible supply and return fuel lines.
- .9 Replaceable dry element air cleaner with restriction indicator.
- .10 Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.
- .11 Engine mounted battery charging alternator, with solid-state voltage regulator.

### **2.3 Coolant Heater**

- .1 Engine mounted, thermostatically controlled, coolant heater(s) for each engine, UL/CSA listed and labelled, designed to provide proper venting of the system.
- .2 The coolant heater to be installed on the engine with high temperature silicone hose connections; steel tubing wherever the length of pipe run exceeds 300mm; using quick disconnect/automatic sealing couplers allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
- .3 Provide 120Vac or 24Vdc thermostat, installed at the engine thermostat housing with a AC power connection box for a single AC power connection to the coolant heater system.
- .4 The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 40°C in a 0°C ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements.

### **2.4 Exhaust Silencer**

- .1 Shall be in accordance with CSA B139-ON, Ontario installation code for oil burning equipment.
- .2 Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be minimum critical grade (25-35dB attenuation). Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

### **2.5 Battery and Charger**

- .1 Provide battery charger for each generator set battery bank. Generator sets incorporating two battery banks shall be provided with two charger sets separated by diodes so that a fault on one bank cannot affect the other. Charger alarm outputs shall be connected in parallel.
- .2 Chargers shall be UL 1236-BBHH listed and CSA/CUL certified for use in emergency applications; compliant with UL991 requirements for vibration resistance; compliant with the requirements of EN61000-4-5 for voltage surge resistance; EN50082-2 for immunity; EN61000-4-2 for ESD; EN61000-4-3 for radiated immunity; ANSI/IEEE C62.41 category B and IN61000-4-4 for electrically fast transient; EN61000-4-6 for conducted emissions; and FCC Part 15 Class A for radiated emissions.

- .3 The charger shall be capable of charging a fully discharged battery without damage to the charger or battery. It shall be capable of returning a fully discharged battery to fully charged condition within 24 hours. The charger shall be CSA/CUL labelled with the maximum battery amp-hour rating that can be recharged within 24 hours.
- .4 The charger shall incorporate a 4-state charging algorithm, to provide trickle charge rate to restore fully discharged batteries, a bulk charge rate to provide fastest possible recharge after normal discharge, an absorption state to return the battery to 100% charge, and a float stage to maintain a fully charged battery and supply battery loads when the generator set is not operating. In addition, the charger shall include an equalization timer. Charge rates shall be temperature compensated based on the temperature directly sensed at the battery.
- .5 The DC output voltage regulation shall be within  $\pm 1\%$ . The DC output ripple current shall not exceed 1A at rated output current level.
- .6 The charger shall include the following features:
  - .1 Multiple-line alphanumeric display with programming keys to allow display of DC output ammeter and voltmeters (5% accuracy or better), display alarm messages, and perform programming;
  - .2 LED indicating lamp(s) to indicating normal charging condition (green), equalize charge state (amber), and fault condition (red);
  - .3 AC input over-current, over-voltage, and under-voltage protection;
  - .4 DC output over-current protection;
  - .5 Alarm output relay;
  - .6 Corrosion resistant aluminum enclosure.
- .7 Starting and Control Batteries shall be calcium/lead antimony type, 12 or 24Vdc, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

## 2.6 AC Generator

- .1 The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated re-greasable bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet temperature limits for specified insulation system. Actual temperature rise measured by resistance method at full load shall not exceed rated temperature rise.
- .2 The alternator shall be capable of delivering rated kVA output at rated frequency and power factor, at any voltage within  $\pm 5\%$  of rated voltage.
- .3 A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10s.
- .4 The sub-transient reactance of the alternator shall not exceed 0.12 per unit.
- .5 The alternator shall be capable of operation with at least 0.15 per unit reverse kVAr.
- .6 Provide two embedded RTD/thermistor per phase and temperature indication equipment. The control system shall annunciate high alternator temperature as a fault condition.
- .7 Provide anti-condensation heater for the alternator.

## 2.7 Generator Set Controls

- .1 The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions. The control system shall also be designed to allow local and remote monitoring and control of the generator set.
- .2 The control shall be mounted on the generator set, vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
- .3 CONTROL SWITCHES
  - .1 MODE SELECT SWITCH; initiates the following control modes:
    - .1 When in the RUN or MANUAL position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator.
    - .2 In the OFF position the generator set shall immediately stop, bypassing all time delays.
    - .3 In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
  - .2 EMERGENCY STOP push-button; red, "mushroom-head", maintained, push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
  - .3 RESET push-button; clear a fault and allow restarting the generator set after it has shut down for any fault condition.
  - .4 LAMP TEST push-button.
- .4 METERING
  - .1 The generator set shall be provided with a digital microprocessor metering set, 1% accuracy, to indicate generator rms voltage and current, frequency, output current, output kW, kWh, and power factor.
  - .2 Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line to neutral or line to line) simultaneously.
- .5 ENGINE CONTROL FUNCTIONS
  - .1 The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15s each, with 15s rest period between cranking periods.
  - .2 The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.
  - .3 The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.
  - .4 The control system shall include time delay start, adjustable 0-300s, and time delay stop function, adjustable 0-600s.

- .5 The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.
  - .6 Where multiple generators are to be operated in parallel, the control system shall include all interfaces necessary for proper operation with the paralleling equipment provided under this contract. The generator set supplier shall be responsible for complete compliance to all specification requirements for both the generator set and the paralleling equipment.
- .6 ALTERNATOR CONTROL & PROTECTIVE FUNCTIONS
- .1 The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from mis-operation due to a load induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulator shall be full wave rectified design, be equipped with three-phase rms sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58-59 HZ. The voltage regulator shall include adjustments for gain, damping and frequency roll-off. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level.
  - .2 Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over-current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60s. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over-current shutdown).
  - .3 Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
  - .4 Controls shall be provided to monitor the load on the generator set, and initiate an alarm condition (over-load) when total load on the generator set exceeds the generator set rating for in excess of 5s. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
  - .5 A line to neutral AC over/under voltage monitoring system that responds to true rms voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10s, instantaneously when voltage exceeds 130%. Under-voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10s.
  - .6 A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is outside limits of 25-32V. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 15V for more than 2s a "weak battery" alarm shall be initiated.
  - .7 Control shall be provided to include a ground fault monitoring. The relay shall be adjustable from 0-1200A, and include adjustable time delay of 0-10s.
  - .8 The voltage regulation system shall include provisions for reactive load sharing and electronic voltage matching for paralleling applications. Motorized voltage adjust pot is not acceptable for voltage matching.

.7 ALARM AND STATUS DISPLAY

- .1 The generator set shall be provided with LEDs indicating lights and multi-lined digital display to indicate generator status, alarms, warnings and shutdown conditions.
- .2 LED indicating lamps shall display as a minimum (1) genset running status, (2) not in auto alarm, (3) common warning alarm, and (4) common shutdown/fault alarm.
- .3 Following statuses shall be available on a digital display: engine oil pressure and temperature, engine coolant temperature, engine oil temperature, engine speed, number of hours of operation, number of start attempts, and battery voltage.
- .4 Following alarms, warnings and shutdown conditions shall be available on an alphanumeric digital display panel:
  - .1 Low oil pressure (alarm & shutdown), oil pressure sender failure (alarm);
  - .2 Low/high coolant temperature (alarm) and high coolant temperature (shutdown), engine temperature sender failure (alarm);
  - .3 Low coolant level (alarm or shutdown), low fuel tanks (alarm)
  - .4 Fail to crank (shutdown), fail to start/over-crank (shutdown), over-speed (shutdown);
  - .5 Low/high DC voltage (alarm), weak battery (alarm);
  - .6 AC over-/under-voltage (shutdown), under-/over-frequency (shutdown), over-current (warning and shutdown), short-circuit (shutdown), ground fault (alarm and shutdown), overload (alarm);
  - .7 Emergency stop (shutdown).
- .5 The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

.8 CONTROL INTERFACES FOR REMOTE MONITORING & CONTROL

- .1 All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure.
- .2 Provide one (1) input contact for engine remote start command, and six (6) customer configurable relay output contacts rated A300/P300.
  - .1 Unless otherwise specified, relay output contacts to be configured for (1) genset running status, (2) not in auto alarm, (3) common warning alarm, (4) common shutdown/fault alarm, (5) fuel high level alarm, and (6) fuel low level alarm.

**2.8 Generator Circuit Breaker**

- .1 The generator set shall be provided with generator breaker, a molded case circuit breakers to CSA C22.2 No. 5 / UL 489, high dielectric strength polyester thermoset case, with gang-operated, quick-make, quick-break, mechanically trip-free, switching mechanism, with non-welding high-conductive contact material and arc chutes for arc extinction, with push-to-trip test button on the front.
  - .1 Provide 100% rated moulded case circuit breakers with electronic trip unit, CSA/UL certified for application at 100% of their continuous ampere rating in their intended enclosure.
  - .2 Provide an electronic trip unit consisting of current sensors and rating plug, microprocessor based true-rms trip device, with Individually adjustable time/current

curve shaping functions: long time pickup (LTPU) with I<sup>2</sup>t time delay (LTD); short time pickup (STPU) with definite and I<sup>2</sup>t time delay (STD); instantaneous pickup (ITPU) with OFF setting and override; and ground-fault pick-up (GFPU) with definite and I<sup>2</sup>t time delay (GFD).

- .3 Submit time over-current characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

## **2.9 Wiring and Terminations**

- .1 Provide wiring and terminations in accordance with Section 16000 Common Work for Electrical.
- .2 The generator set load connections shall be composed of tin-plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
- .3 Power connections to auxiliary devices shall be made at the devices, with required protection located at common distribution panel or junction box.
- .4 Generator set control interfaces to other system components shall be made on a common, permanently labelled terminal block assembly.

## **2.10 Outdoor Weather-Protective Sound Attenuating Housing**

- .1 Where specified, generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions as specified. The enclosure shall provide ample airflow and reduce the sound level of the generator set while operating at full rated load as specified in a free field environment.
- .2 Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fibreglass.
- .3 The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and padlock able door latches shall be provided for all doors. Door hinges shall be stainless steel. All units shall be keyed alike.
- .4 The enclosure shall be provided with an exhaust silencer, which is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust, including any inlet ducts, shall include a raincap and rainshield.
- .5 Provide motorized louvers to minimize air flow through the enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.
- .6 All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color. All surfaces of all metal parts shall be primed and painted.
- .7 Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
- .8 Provide an external emergency stop switch that is protected from accidental actuation.
- .9 Unless otherwise specified, provide factory mounted and wired electrical distribution panel to serve the generator set and enclosure. Include factory installed and pre-wired 60A, 120/208Vac, 3ph/4w distribution panelboard, complete with branch circuit wiring for: engine

coolant and alternator heaters; battery charger; motorized louvers; two (2) duplex GFI receptacles, one inside the enclosure, and a weatherproof receptacle on the outside of the enclosure; two (2) three-way switches controlling three (3) 120Vac vapour-tight gasketed lighting fixtures.

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.
- .2 Perform complete operational, functional and performance tests on the generator set prior to shipping from the factory. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory tested at rated power factor will not be accepted.
- .3 The following routine factory tests shall be performed in accordance with the latest revision of ANSI/IEEE, NEMA, CSA and CUL/UL standards: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.
- .4 Provide a certified test report.
- .5 Provide factory test witnessing for up to two (2) Owner's representatives.

#### **3.2 Installation, Field Quality Control, Start-up and Commissioning**

- .1 Install generator set and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 Provide fully engineered structural reinforced concrete generator pad as detailed on drawings. Unless otherwise specified, the pad shall be placed on the undisturbed soil, with minimum of 600mm crushed stone, compacted to 95% SPD.
- .3 Install generator set on concrete housekeeping pad, permanently fastened in accordance with manufacturer's instructions and seismic requirements of the site.
- .4 Provide all interconnecting wiring for the on-site power system. Provide interconnecting wiring between equipment sections, where required, under the supervision of the equipment supplier.
- .5 The complete installation shall be tested, commissioned and start-up by Manufacturer's Service Representative, witnessed by the Owner's Representative.
- .6 The Contractor to supply all fuel required for commissioning. On completion of the commissioning and start-up, the Contractor shall supply full tank of #2 Diesel fuel.
- .7 Provide 3<sup>rd</sup> party TSSA certified inspection report of installation of equipment. Certifying that equipment meets the requirements of TSSA and CSA B139-ON. This inspection report is required at time of site acceptance test (SAT) if not provided at time of SAT the testing will be considered failed.
  - .1 Provide any required additional testing and modification as required by TSSA inspection.

**3.3 Manufacturer's Certification and Training**

- .1 Provide manufacturer's certification and training in accordance with Section 16000 Common Work for Electrical and as modified herein.

**3.4 Service and Support**

- .1 The Manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year for duration of the warranty period.
- .2 The Manufacturer shall provide a critical parts list for storage on site.
- .3 The Manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

**End of Section**

## 16621 Low Voltage Transfer Switches

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for low voltage automatic or manual transfer switches.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No.178.1 / UL 1008 - Transfer Switch Equipment

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

#### 1.4 Summary of Automatic Sequence of Operation

- .1 Transfer
  - .1 Upon loss of the utility source, the standby generator start signal will be initiated after a time delay engine starting (TDES, 0-120s) expires.
  - .2 After the generator source is attained, the utility source will be disconnected after a time delay normal-to-emergency (TDNE, 0-1,800s) expires.
  - .3 Load will be connected to the generator source after a time delay neutral (TDN, 0-120s) expires.
- .2 Retransfer
  - .1 When the utility source has been restored, the generator will be disconnected after time delay emergency-to-normal (TDEN, 0-1,800s) expires.
  - .2 Load will be re-connected to the utility source after a time delay neutral (TDN, 0-120s) expires.
  - .3 For the generators without programmed cool-down timer, after the loads is re-transferred, the generator source will be shut down after a time delay engine cool (TDEC, 0-1,800s) expires.
  - .4 If the generator should fail while carrying the load, re-transfer to the normal power supply shall be made instantaneously upon restoration of the normal source to satisfactory conditions

### 2.0 Products

#### 2.1 Summary of Ratings and Characteristics

- .1 Provide automatic transfer switch of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Type</b>	Automatic transfer switch, open transition, 2-source, 3ø/3w/3p
<b>Power Switching Devices</b>	Moulded case switch
<b>Voltage</b>	600V for 600V 3ø/3w
<b>BIL</b>	10kV
<b>Frequency</b>	60Hz
<b>Continuous Current Rating</b>	200A
<b>Short-circuit Current Rating</b>	25kASCR
<b>Enclosure</b>	Painted Steel, CSA 1, indoor
<b>Acceptable Manufacturers</b>	Eaton /w ATC-900 or ATC-300 controller, Thompson Power Systems /w TSC 7320 controller

- .2 The transfer switch shall be 100% rated for continuous duty as shown on the drawings without de-rating, either open or enclosed.
- .3 The transfer switch shall have short-circuit rating sufficient for the voltage and the available short circuit current at the point of application, without utilizing series rating with upstream devices.
- .4 The transfer switch shall be rated for application with upstream over-current protective devices that do not incorporate instantaneous trip units having short time delay settings of up to 30 cycles.

**2.2 Construction**

- .1 Transfer switch shall consist of completely enclosed power switching devices with integrated, programmable door-mounted controller.
- .2 The power switching devices shall be equipped with stored energy mechanism which shall be operated by a non-fused motor operator, and be energized only momentarily during transfer, providing double throw switching action. Alternatively, power switching devices shall be electrically operated.
- .3 Transfer switch shall be capable of being operated manually under full load conditions. Manual operation shall be accomplished via removable manual operating handle. The manual operator shall provide the same contact-to-contact transfer time as provided under normal automatic operation to prevent possible flashovers from switching the main contacts slowly. In addition, provisions shall be made to allow disengagement of the electrical operator during manual operation.
- .4 Transfer switch shall be positively interlocked both mechanically and electrically to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be mechanically locked in position in both normal and emergency positions.
- .5 Transfer switch shall have a neutral position when operated both automatically and manually. A transfer switch position indicator shall be visible from the front of the switch to show to which source the transfer switch is connected.
- .6 Where specified, a fourth (neutral) pole contacts shall be of identical construction as, and operate simultaneously with, the main power contacts. Add-on overlapping neutral contacts are not acceptable. Where solid neutral is required, it will be fully rated.

### 2.3 Control Power

- .1 Provide control voltage transformers, one per each source, line-line rated primary and 120V secondary windings, c/w primary and secondary fusing as required, with thermal VA rating to suite application.
- .2 Control power for transfer operations shall be derived from the line side of the source to which the load is being transferred to.
- .3 All components shall be dead front and finger safe.

### 2.4 Automatic Transfer Controller and Operator Interface

- .1 Provide microprocessor-based sensing and control logic automatic transfer switch controller (ATC), separately mounted from the power switching portion of the transfer switch, with door-mounted programming and indication graphical color touch screen operator interface (OIT).
- .2 The control and power section shall be connected by control cables with plug-in connectors and shall be capable of being disconnected for maintenance and testing purposes.
- .3 The ATC shall be an Intelligent Electronic Device (IED) which shall have a unique Internet Protocol (IP) Address for programming/configuring and remote communication.
- .4 The ATC shall be capable of operating in conjunction with other ATS controllers on a common Ethernet communication network.
- .5 The ATC shall provide the following key features:
  - .1 Open and/or closed transition transfer control;
  - .2 Utility and generator voltage and frequency metering;
  - .3 Control function timing;
  - .4 8 programmable relay output contacts;
  - .5 16 programmable digital inputs; and
  - .6 Engine start output contact.
- .6 The OIT shall provide easy to navigate software menu screens for all ATS system information and control. The following minimum information shall be displayed:
  - .1 System Time/Date;
  - .2 ATS Power Mimic Bus;
  - .3 Source Available/ATS Position Indication;
  - .4 Utility and generator source metering - 3 $\emptyset$  voltages and frequency;
  - .5 Load bus metering - 3 $\emptyset$  voltages and frequency, current, active/reactive/apparent power (kW/kVAr/kVA) and power factor;
  - .6 Timer countdown;
  - .7 ATS control modes (Auto/Off/Manual/Engine Start); and
  - .8 Events and alarm summary and logs.
- .7 Provide ATS fully integrated load bus power metering 3 $\emptyset$  power meter, accuracy  $\pm 1.5\%$ .
  - .1 Provide current transformers on all phases complete with current shortening switch, rated to meet the ATS full load current.
  - .2 Power metering accuracy of the controller shall be  $\pm 1.5\%$  for kW, kVAR and KVA power values.
  - .3 Power metering shall include load 3 $\emptyset$  currents, load bus 3 $\emptyset$  active/reactive/apparent power (kW/kVAr/kVA) and power factor.

## **2.5 Local Control and Indication**

- .1 Where not provided with OIT functionality, provide TEST / AUTO / MANUAL / ENGINE START 4-position door-mount selector switch in accordance with Section 16825 Electrical Control Devices and Relays.
  - .1 Test or On-load Test position - simulates normal power failure. Engine starts and transfer takes place. Return switch to Auto to stop the 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.
  - .4 Engine Start or Off-load Test position - Engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to AUTO to stop the engine.
  - .5 Provide additional contact for remote indication of AUTO position.
- .2 Where required, provide interposing relays and timers in accordance with Section 16825 Electrical Control Devices and Relays.
- .3 Unless otherwise noted, provide A300/P300 rated potential-free contacts for status indication, wired to the customer terminal blocks, and programmed as follows:
  - .1 One (1) for generator run command;
  - .2 Two (2) for ATS power switching device position status;
  - .3 Two (2) for ATS sources status;
  - .4 One (1) for ATC General alarm; and
  - .5 One (1) for ATC not-in-auto status.

## **2.6 Wiring and Terminations**

- .1 Provide wiring and terminations in accordance with Section 16000 Common Work for Electrical.

## **3.0 Execution**

### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control & factory testing in accordance with Section 16000 Common Work for Electrical.

### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install ATS and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.

### **3.3 Manufacturer's Certification and Training**

- .1 Provide manufacturer's certification and training in accordance with Section 16000 Common Work for Electrical.

**End of Section**

## 16671 Surge Protective Device

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for surge protective devices arresters for safeguarding low voltage equipment on alternating current system against transient over voltages.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 C22.2 No. 269.1 - Surge protective devices - Type 1 - Permanently connected
- .2 C22.2 No. 269.2 - Surge protective devices - Type 2 - Permanently connected
- .3 C22.2 No. 269.3 - Surge protective devices - Type 3 - Cord connected, direct plug-in and receptacle type
- .4 C22.2 No. 269.4 - Surge protective devices - Type 4 - Component assemblies
- .5 UL 1449-Surge Protective Devices
- .6 ANSI/IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

#### 1.3 Submittals

- .1 Provide product data, shop drawings, operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.

### 2.0 Products

#### 2.1 Summary of Ratings and Characteristics

- .1 Provide surge protective devices of the quantity and ratings as indicated on the drawings and/or schedules, and unless indicated otherwise, the ratings, characteristics and accessories as indicated herein.

<b>Type</b>	Online, double-conversion topology, frequency independent operation, with static bypass switch and 3-position maintenance bypass switch
<b>Voltage</b>	600Y/347 (3 $\phi$ /4w)
<b>Type / Modes of Operation</b>	L-N, L-G, N-G, L-L (3 $\phi$ /4w)
<b>Surge Capacity per phase</b>	120kA
<b>Short Circuit Current</b>	200kA
<b>Frequency</b>	60Hz

## 2.2 Design Requirements

- .1 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
- .2 The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
- .3 The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
- .4 Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.
- .5 Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
- .6 Each SPD shall provide the following integral monitoring options:
  - .1 Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
    - .1 For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
    - .2 For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
    - .3 The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
  - .2 The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
  - .3 The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
  - .4 The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of  $50 \pm 20A$  occurs.

A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

.1 The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

.7 **Overcurrent Protection**

.1 The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

.8 All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

.9 **Safety Requirements**

.1 The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

.2 SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

.3 Side mount SPDs shall be factory sealed in order to prevent access to the inside of the unit. Side mount SPDs shall have factory installed phase, neutral, ground and remote status contact conductors and shall have a pigtail of conductors protruding outside of the enclosure for field installation.

**2.3 Side mount Mounting Applications Installation (SPD mounted external to electrical assembly)**

.1 Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

**3.0 Execution**

**3.1 Manufacturer's Quality Control & Factory Testing**

.1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.

- .2 Standard factory tests shall be performed on the equipment under this section. All tests shall be in accordance with the latest version of UL, CSA standards.

### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install the equipment and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.

**End of Section**

## 16825 Electrical Control Devices and Relays

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for electrical and control devices installed as a part of the switchgear, switchboard, motor control centre, enclosed controllers, or mounted in standalone enclosure.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 CSA C22.2 No. 60947-5-1 / UL 60947-5-1 - Low-Voltage Switchgear and Controlgear - Part 5-1: Control Circuit Devices and Switching Elements - Electromechanical Control Circuit Devices
- .2 CSA C22.2 No. 60947-7-1 / UL 60947-7-1 - Low-Voltage Switchgear and Controlgear - Part 7-1: Ancillary Equipment - Terminal Blocks for Copper Conductors
- .3 CSA C22.2 No. 60947-7-2 / UL 60947-7-2 - Low-Voltage Switchgear and Controlgear - Part 7-2: Ancillary Equipment – Protective Conductor Terminal Blocks for Copper Conductors
- .4 CSA C22.2 No. 60947-7-3 / UL 60947-7-3 - Low-Voltage Switchgear and Controlgear - Part 7-3: Ancillary Equipment - Safety Requirements for Fuse Terminal Blocks
- .5 CSA C22.2 No. 61010-1 / UL 61010-1 - Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements
- .6 CSA C22.2 No. 61010-2 / UL 61010-2 - Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 2 (collection)
- .7 C22.2 NO. 25 - Enclosures for Use in Class II Groups E, F and G Hazardous Locations
- .8 CSA C22.2 No. 30 - Explosion-Proof Enclosures for Use in Class I Hazardous Locations
- .9 CSA/C22.2 No. 39-Fuseholder Assemblies
- .10 CSA C22.2 No. 94.1 / UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations
- .11 CSA C22.2 No. 94.2 / UL 50E - Enclosures for Electrical Equipment, Environmental Considerations
- .12 CSA C22.2 No. 107.1 – Power Conversion Equipment
- .13 CSA C22.2 No. 107.2 – Battery Chargers
- .14 CSA C22.2 No. 107.3 / UL 1778– Uninterruptable Power Systems
- .15 CSA C22.2 No. 142 - Process Control Equipment
- .16 CSA C22.2 No. 157 - Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations

- .17 CSA C22.2 No. 158 - Terminal Blocks
- .18 CSA C22.2 No. 213 - Non-incentive Equipment for Use in Class I, Division 2 Hazardous Locations
- .19 CSA C22.2 No. 223 - Power Supplies with Extra-Low-Voltage Class 2 Outputs
- .20 CSA C22.2 No. 248 - Low voltage fuses (including all parts)
- .21 CSA C22.2 No. 286 - Industrial Control Panels and Assemblies
- .22 CSA-E60079 - Hazardous Location Equipment (all parts)
- .23 CSA C22.2 No. 0.12 - Wiring Space and Wire Bending Space in Enclosures for Equipment Rated 750V or Less
- .24 UL 1203 - Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
- .25 NEMA ICS 1 - Industrial Control and Systems General Requirements
- .26 NEMA ICS 6 - Industrial Control and Systems Enclosures

## **2.0 Products**

### **2.1 Pushbuttons and Selector Switches**

- .1 Heavy duty, 30.5mm, oil-tight.
- .2 Momentary, 2-position green or red push-button, labeled START or STOP, contact arrangement and nameplate as indicated; others as indicated.
- .3 Maintained, 2-position red push-button, labeled STOP or E-STOP, with mushroom head, contact arrangement and nameplate as indicated.
- .4 Maintained, multiple position selector switch, labeled as indicated, with knob operator, contact arrangement and nameplate as indicated.
- .5 Contacts: NEMA A300 / P300 rated for 120V ac or 24Vdc control application, NEMA A600 / P600 rated for 600V or 120V ac line application, sealed contact, moulded thermoplastic stackable contact blocks.
- .6 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Schneider, Siemens.

### **2.2 Indicating lights**

- .1 Heavy duty, 30.5mm, oil-tight, LED type, continuous light or flashing, push-to-test, lens colour, supply voltage and labels as indicated.
- .2 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Schneider, Siemens.

### **2.3 Control Relays and Timers**

- .1 Fixed contact type, heavy duty, electrically held, with solid state timer where indicated, and 2-12 NO or NC contacts. Coil rating: 120Vac or 24Vdc as indicated. Contact rating: A300/P300, silver contacts are not allowed.
- .2 Fixed contact, plug-in type, sealed, general purpose, with solid state timer where indicated, and 1-6 SPDT contacts. Coil rating: 120Vac or 24Vdc as indicated. Contact rating: NEMA A300/P300.
- .3 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Phoenix, Schneider, Siemens, Weidmuller.

## **2.4 Intrinsically Safe Relays**

- .1 Intrinsically safe relays, 24Vdc power supply, 1- or 2-channel isolated barrier, dry contact or NAMUR inputs, two (2) Form-C output relays A300/P300 rated.
- .2 Acceptable manufacturers: Pepperl-Fuchs KFD2-SR2-Ex2.W, or approved equal.

## **2.5 Intrinsically Safe Isolators**

- .1 Intrinsically safe isolators, 1-channel, loop power,.
- .2 Acceptable manufacturers: Stahl, 9001/01-280-110-101, or approved equal.

## **2.6 Circuit Breakers**

- .1 Branch protector miniature circuit breakers, thermal-magnetic or hydraulic magnetic, 120Vac, 60Hz, 5kA rated, DIN-rail mounted.
- .2 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Phoenix, Schneider, Siemens, Weidmuller.

## **2.7 Fuses**

- .1 Fuses with dead-front fuse holder.
- .2 Midget or CC type, 120Vac/125Vdc rated, current rating as indicated.
- .3 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Phoenix, Mersen, Schneider, Siemens, Weidmuller.

## **2.8 Terminal Blocks**

- .1 120Vac/125Vdc rated, current rating as required, DIN-rail mounted, screw connection type terminal blocks.
- .2 Feed-through power distribution and grounding (including shields).
- .3 Feed-through /w knife for all discrete and analog I/Os.
- .4 Fused c/w glass fuses for DC distribution as required.
- .5 Nameplate mounting.
- .6 Acceptable manufacturers: ABB, Allen-Bradley, Eaton, Phoenix, Schneider, Siemens, Weidmuller.

## **2.9 Control Power Transformer**

- .1 An 120Vac control power transformer, with dead-front fuse blocks, primary fuses installed in both phases and secondary fuse installed in one phase with other phase grounded.
- .2 All components shall be dead front and finger safe.

## **2.10 Uninterruptable Power Supply**

- .1 Provide UPS Eaton Powerware 9PX/9SX, 120Vac, c/w relay card for low battery alarm, bypass alarm, fault alarm, line power available, provide interposing relays as required, rack and tower as required.

## **2.11 Power Supplies**

- .1 Primary switched, switch mode power supply, 120Vac/24Vdc, rating as indicated, with built-in or external redundancy module.

- .2 24Vdc power supplies shall be redundant at all times when installed within RPU/PLC control panels, communication cabinets, anytime the functions are for mission critical functions such as switchgear, ATS, or generator controls.
- .3 Acceptable Manufacturers:
  - .1 Power supply for control panels: Phoenix Contact, QUINT4-PS, Weidmuller PROtop /w built-in redundancy module.
  - .2 Redundancy module: Phoenix Contact, QUINT-ORING.

### **3.0 Execution**

- .1 Install individual components within assemblies as required, install control panels and stations, and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical.
- .2 Unless otherwise specified, provide hollow aluminum post or Unistrut type support for mounting of units on the common backplane. Provide all necessary mounting hardware as required.
- .3 Provide floor supports for mounting units on the concrete floor; provide frost-free concrete footings for mounting outdoors on the native soil.

**End of Section**

## 16900 Process and Building Instrumentation

### 1.0 General

#### 1.1 Scope

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for process and building instrumentation for measurement of flow, pressure, level, temperature, analytical variables, etc.
- .2 For common criteria see Section 16000 Common Work for Electrical.
- .3 Provide devices, components, accessories and control panels for the operation of the complete and working instrumentation and control system. Coordinate instrumentation supply and installation to assure proper interface and system integration.
- .4 Provide signal processing equipment, to include, but not be limited to, process sensing and measurement transducers, signal converters and conditioners, transmitters, receivers and power supplies.
- .5 Provide services of qualified, manufacturer trained and certified, field personnel to check out, test, calibrate, commission, troubleshoot and adjust system until acceptance by the Engineer and Owner.

#### 1.2 Standards

- .1 CSA C22.2 No. 14 - Industrial Control Equipment
- .2 UL 508 - Standard for Industrial Control Equipment
- .3 CSA C22.2 No. 94.1 / UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations
- .4 CSA C22.2 No. 94.2 / UL 50E - Enclosures for Electrical Equipment, Environmental Considerations
- .5 CSA C22.2 No. 142 - Process Control Equipment
- .6 CSA-C22.2 No. 157 - Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations
- .7 CSA C22.2 No. 61010-1 / UL 61010-1 - Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements
- .8 CSA C22.2 No. 61010-2 / UL 61010-2 - Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 2 (collection)
- .9 NEMA ICS 1 - Industrial Control and Systems General Requirements
- .10 NEMA ICS 6 - Industrial Control and Systems Enclosures
- .11 ANSI/ISA-S5.1 - Instrumentation Symbols and Identification
- .12 ANSI/ISA-S5.4 - Instrument Loop Diagrams
- .13 ISA-20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves
- .14 ISA-TR20.00.01 - Specification Form for Process Measurement and Control Instruments, General Consideration

- .15 ISA-S50.1 - Compatibility of Analog Signals for Electronic Industrial Process Instruments

### **1.3 Product Data and Shop Drawings**

- .1 Provide product data and shop drawings in accordance with Section 16000 Common Work for Electrical.
- .2 Also submit the following:
  - .1 Instrument data sheets, conforming to ISA-20.
  - .2 Descriptive literature.
  - .3 Manufacturer's installation diagrams for field mounted equipment.
  - .4 Proposed instrument panel/backplane layout drawing.
  - .5 Instrument and instrument panel wiring diagrams.

### **1.4 Operating and Maintenance Instruction Manuals, and Record Documentation**

- .1 Provide operating and maintenance instruction manuals, and record documentation in accordance with Section 16000 Common Work for Electrical.
- .2 Also submit the following:
  - .1 Manufacturer's calibration certificates.
  - .2 Instrument field calibration sheets.
  - .3 Instrument field loop check sheets.

### **1.5 Specified, Acceptable and Alternative Instrument Manufacturers**

- .1 For general requirements for specified, acceptable and alternate manufacturers, equipment and materials see Section 16000 Common Work for Electrical.
  - .1 The design has been based on the specified instruments that are referenced by manufacturer's name and type / catalogue number.
  - .2 If more than one instruments are referenced by manufacturer's name and type / catalogue number, only first in the list is specified instrument; others, including instruments referenced by manufacturer name only, are considered acceptable alternatives.

## **2.0 Products**

### **2.1 General**

- .1 Provide instruments of a certain type from one manufacturer for entire project.
- .2 Provide only new and of current manufacture, made or stocked in Canada, standard, first-grade materials and instruments throughout, conforming to standards established by CSA/cUL, and so marked or labelled.
- .3 Provide specified instruments for the continuous measurement of the process variables, that are microprocessor based, self-checking, fully programmable indicating transmitters and primary elements (transducers), primary element with integrated indicating transmitter, or primary element with integrated blind transmitter, c/w galvanically isolated inputs and outputs, as specified herein and shown on the drawings.
- .4 Provide specified instruments for discrete measurements of process conditions c/w galvanically isolated outputs actuated by the changes of set process conditions, as specified herein and shown on the drawings.

- .5 Provide instruments complete with process connections, mounting hardware, floor stands, wall brackets and/or instrument racks as required for complete and operational system to the satisfaction of the Engineer.
- .6 Provide manufacturer recommended/supplied cables for connection between primary elements (transducers) and transmitters, continuous without any splices, factory sealed at the transducer, c/w wireways, mounting hardware, and cable connectors and glands as required.
- .7 Supply field-mounted indicators calibrated in metric engineering units.
- .8 All Manufacturer's recommendations for installation must be followed. If for special conditions, the instrument will not be installed as recommended, the deviation must be clearly highlighted in the shop drawing submission.
- .9 Provide instrument enclosures CSA/NEMA rated for the environment. In hazardous areas, meet the CSA Code Zone, Class, Division and Group as specified. In areas subject to flooding, provide submergence rated enclosures as specified.
- .10 Provide programming units, cabling and programming software for all programmable instruments.
- .11 Unless otherwise specified, all analog inputs and outputs to be 4-20mA, linear, live-zero signals, proportional to the measured and derived variables. All discrete outputs to have NEMA rated contacts: NEMA A300 / P300 rated for 120Vac or 24Vdc control application, NEMA A600 / P600 rated for 600Vac or 120Vac/120Vdc line application.
- .12 All carbon steel/aluminum process connections and instrument enclosures shall be Zn/Al painted/power-coated, colour to match process piping colour. See individual specification sections for more details.
- .13 Where pre-packaged, stand-alone control systems are supplied under other divisions of this specification, provide wiring to connect to the required remote monitoring and/or control functions. Provide end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other divisions of this specification.

## 2.2 Magnetic Flow Transmitters

### Summary of Standard Ratings and Characteristics

Tag	FIT-101, Discharge Flow Meter
Approvals	CSA
Hazardous Area Approvals	CSA, cUL: Div 1 / Class 2
Ambient Temperature	-20 to 40°C
Humidity	0 to 100%
Sensor (FE)	
Fluid	Wastewater with some grit (raw or treated),
Connection	ANSI B16.5 Class 150, 316L SS flanges, alternatively carbon steel to match process piping where indicated
Tube	150mm, 316LSS
Liner Material	Polyurethane (-20 / 50°C) for wastewater
Electrode	Bullet nose 316L SS
Housing	CSA/NEMA 6P IP68, coated die-cast aluminum
Grounding Rings	No
Empty Pipe Detection	Yes
Bidirectional	No
Sensor Cable Length	As required for remote version, without splices, with additional protection for area classification
Min/Max Velocity Range	0.1 to 10m/s
Transmitter (FIT)	
Enclosure	CSA 4/4X enclosure; Remote version: polycarbonate, alternatively die-cast aluminum;
Display / Operation	Backlit LCD display with touch control, and operational software for communicating version
Primary Process Units	Flow [l/s]
Secondary Process Units	Total flow [m3] or [l]
Process Unit Range	0-200L/s
Accuracy	0.5%
Rangeability	100:1
Response Time	0.5s
Full Scale Flow	~2.5m/s, unless specified otherwise
Low Cut-off Flow	~0.04m/s, unless specified otherwise
Power Supply	120Vac, 60 Hz
Analog Outputs	4 - 20 mA (0)
Pulsed Outputs	No
Relay Outputs	Form C (0)
Communications	Ethernet IP /w integrated web server
Manufacturers	Endress+Hauser Promag W 400, /w Proline 400; Siemens Sitrans F M MAG5100W, /w MAG 6000



**2.3 Radar Level Transmitters**

**Summary of Standard Ratings and Characteristics**

Tag	LT-101, Wetwell level measurement
Approvals	CSA
Hazardous Area Approvals	CSA, cUL: Ex ia
Ambient Temperature	-40 to 130°C
Humidity	0 to 100%
Sensor (LE):	
Fluid	Wastewater with some grit
Body Material	AL, polyester coated.
Face Material	PP cladded plastic
Process Connection	SS Wall mounted bracket
Submergence	Yes 24h @ 1.00m
Housing	CSA/NEMA 6P, IP68
Process Unit Range	0-15m
Linearity	3-point
Radar Frequency	26GHz
Horn Size	mm
Horn Material	PP Cladded
Beam Angle	8°
Analog Outputs	4-20mA HART (Loop Powered)
Communications	N/A
Accessories	316SS wall mounting bracket
Transmitter	Refer to 16900.2.6 Level Controller
Manufacturers/Models:	Siemens, LR120 Endress+Hauser, Micropilot FMR50;

## 2.4 Pressure Transmitters

### Summary of Standard Ratings and Characteristics

Tag	PIT-101, Discharge Pressure
Approvals	CSA
Hazardous Area Approvals	CSA, cUL: Div 1 / Class 2
Ambient Temperature	-20 to 40°C
Humidity	0 to 100%
Transmitter (PE)	
Media	Wastewater with some grit (raw or treated)
Measurement Type	Gauge pressure, differential where indicated
Process Connection	Threaded diaphragm seal /w isolation ball valve
Transmitter (PIT)	
Enclosure	Compact version or blind, CSA/NEMA 4X, IP66 enclosure; alternatively die-cast aluminum
Display / Operation	Backlit LCD display with touch control, and operational software for communicating version
Process Units	[kPa]
Process Unit Range	2,000kPa (absolute or diff.)
Temperature Range	-20 / 80°C
Accuracy	0.1%
Rangeability	100:1
Response Time	0.5s
Power Supply	Loop
Analog Output	4-20mA (1)
Communication	No;
Manufacturer	Endress+Hauser PMP71; Siemens P320; Rosemount, 3051T;
Manufacturer (Threaded diaphragm seal)	Ashcroft 100 series, 316LSS including hardware, or approved equal

**2.5**

**Level Controller**

**Summary of Standard Ratings and Characteristics**

Tag	LIT-101, Wetwell Level Controller
Approvals	CSA
Hazardous Area Approvals	N/A
Ambient Temperature	-20 to 40°C
Humidity	0 to 100%
Transmitter (LIC)	
Enclosure	Remote, polycarbonate, CSA/NEMA 3
Display / Operation	Backlit LCD display with remote controller, and programming software
Process Units	[m]
Accuracy	0.25%
Resolution	0.1%
Linearity	0.5%
Response Time	0.5 sec
Power Supply	120Vac, 60 Hz
Sensor Inputs	2
Sensor Type	mA
Analog Inputs	4-20mA (2)
Analog Outputs	4-20mA (2)
Relay Outputs	Form A (2), Form C (4)
Communications	Ethernet/IP
Manufacturers/Models	Siemens LT500

**2.6**

**Level Switches**

**Summary of Standard Ratings and Characteristics**

Tag	LSHH-101, LSLL-101, Wetwell level switches
Approvals	CSA
Hazardous Area Approvals	CSA, cUL: Ex ia
Ambient Temperature	-20 / 40°C
Humidity	0 / 100%
Primary Element (LS)	
Fluid	Wastewater with some grit
Type	Mechanical Switch
Body Material	Polypropylene
Degree of Protection	CSA/NEMA 6, IP68
Min/Max Temperature	0 / 60°C
Min/Max Density	0.65 / 1.5 g/cm <sup>3</sup>
Mounting	Wall bracket & rings
Mounting height	See drawings and schedules
Contacts	Form C (1)
Cable	3c, PVC jacket, SOW, 13m
Local JBX	Yes
EX-isolating Barrier	Yes
Manufacturer/Models	Xylem Flygt, ENM-10

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.
- .2 Provide calibration of all instruments. The Calibration Certificates shall be shipped with the instruments; the original documents shall be submitted to the Engineer and copies shall be included in the Operations and Maintenance Manual.

#### **3.2 Planning and Coordination of Services or Installations**

- .1 Plan and coordinate services and installation in accordance with Section 16000 Common Work for Electrical.
- .2 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other division's installation work.

#### **3.3 Delivery, Storage and Handling**

- .1 Provide and securely attach the tag number and instructions for proper field handling and installation to each instrument prior to packaging.
- .2 Package instrumentation to provide protection against shipping damage, dust, moisture and atmospheric contaminants.
- .3 Transport, unload, store and handle instrumentation at the site. Inspect instrumentation for damage in shipment and return damaged instrumentation to the manufacturer. Store instruments indoors, in dry, clean and temperature-controlled storage facilities.

#### **3.4 Field Installation**

- .1 Provide field instruments as indicated in accordance with Section 16000 Common Work for Electrical.
- .2 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Engineer prior to installing any equipment of this type.
- .3 The instrument locations are to be coordinated with the installation of adjacent equipment under other Divisions, but locations must be approved by the Engineer prior to installation.
- .4 Equipment, supplied under other Divisions/Sections, but interconnected with Work of this Section will be either mounted by these other Divisions/Sections or, handed over for installation by this Section as indicated.
- .5 Provide process connections, mounting hardware, floor stands, wall brackets and/or instrument racks as required for complete and operational system to the satisfaction of the Engineer.
- .6 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage to finish, proper operation or life expectancy.
- .7 Obtain and use instrument mounting details from the manufacturer or supplier for installation purposes. Where the instrument installation details furnished with the Specification and Drawings conflict with the manufacturer's installation detail, mount the instrument in accordance with manufacturer's specifications and instructions. Prior to installation, obtain the ruling and approval from the Engineer.

- .8 Unless shown otherwise, do not mount direct reading or electrical transmitters on process piping; mount on instrument racks or stands or in enclosures near the sensor at a level that permits viewing from floor elevation.
- .9 Install the instrumentation and auxiliary devices such that they are accessible for operation and maintenance. Provide space between instruments and other equipment and piping for ease of removal and servicing. Generally, install instrumentation to be accessible from floor level or grade.
  - .1 Locate indicators such that indicator display is readily readable at eye level (1.5–1.6m) from floor elevation.
  - .2 Locate transmitter with adequate clearance and accessibility for service. For pipe/rack mounted instruments at least 1m distance/ clearance to the wall.
  - .3 Allow sufficient clearance for cover removal and adjustment of switches.
  - .4 Provide adequate clearance (100mm minimum) from piping and other obstructions for operation of valve handles.
  - .5 Provide safe access to the sensor.
- .10 Provide field wiring c/w cables, raceway (wireways, conduit, wiring-duct, cable tray, etc.), terminations, etc.
  - .1 Where the instruments are installed in the hazardous areas, provide wiring, sensors/instruments enclosures and intrinsically safety circuitry to meet the CSA Code Class, Group or Division as specified.
  - .2 For remote transmitter units, installed manufacture supplied primary signal cables from primary element / transducer to the transmitter per manufacturer's instructions. Where cables are not supplied by the manufacturer, the Contractor is responsible to provide the required cable. The cables are to be installed without any splices. Where maximum standard cable length is inadequate for the field conditions, provide manufacturer's approved termination box, suitable for the environment.
  - .3 Provide junction/terminal boxes as required and/or indicated on the drawings; terminate cables and conduits as required.
  - .4 Provide liquid-tight flexible metal or non-metallic conduit for up to a meter from the primary sensor or transmitter, or as appropriate to allow removal of it, for the following installations:
    - .1 Where primary sensor signal cables are required to be installed in the conduit.
    - .2 Where cables are required to be installed in the conduit for integral transmitter units.
    - .3 Where vibration of the process piping is excessive, beyond manufacturer's recommendations.
  - .5 Terminate primary sensor cables and conductors at the primary element / transducer (for non-sealed cables) and transmitter in accordance with manufacturer's recommendations, Section 16120 Wires and Cables and Section 16110 Raceways and Boxes.
  - .6 Provide and terminate control power, discrete indication and control, analog indication and control, and communication cables and conductors at transmitters and control panels as indicated on the drawings as directed by the Engineer, in accordance with manufacturer's recommendations, Section 16120 Wires and Cables and Section 16110 Raceways and Boxes.
- .11 Verify all identification legends on equipment and cross-check wiring identification numbers with drawings and schedules.

- .12 Return all damaged equipment to the factory for total corrective repairs. Replace damaged equipment with new product if deemed necessary by the Engineer. The Contractor to bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

### **3.5 Field Quality Control, Start-up & Commissioning**

- .1 Provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.
- .2 After the instrument is fully installed, (including mounting, process connections, signal connections and power connections) and after the process is put into test mode or actual operation, perform preventative maintenance tasks, calibrate the instrument, and perform commissioning and start-up.
- .3 Provide services of a competent Manufacturer's/Supplier's trained and certified technical representative to verify the installation, and provide calibration, adjustment, testing, and troubleshooting of all the instrumentation and control devices and systems until the operation of the systems are satisfactory to the Engineer and Owner.
  - .1 The Contractor is responsible for coordination and scheduling of such a work. Notify the Engineer in writing 5 working days prior to scheduling the visits.
  - .2 Tests shall be carried out either separately or in conjunction with other equipment tests as determined by the Engineer.
  - .3 Prepare instrumentation installation and calibration certification sheet for each primary element sensor and electronic indicator/analyzer/transmitter for each instrument uniquely specified. Utilize this sheet to calibrate, test and record each instrument.
  - .4 Calibrate measurements over the full instrument range, including zero, full range and 3 intermediate points. Repeat 2 times and document all results.
  - .5 Demonstrate alarms by varying process conditions. Repeat 3 times and document all results.
  - .6 Where equipped, calibrate instruments communication to ensure that the device communicates all information to the communication network.
  - .7 Provide record of the calibration and testing to the Engineer after Work is completed; a copy of the field notes before leaving the site if practical, or faxed copy within 12h, and a copy of the final typed-written record report within 48h.
  - .8 In the Instrument Data Sheet, document the results of calibration and note any setting or adjustment made.

### **3.6 Manufacturer's Certification and Training**

- .1 Provide manufacturer's certification and training in accordance Section 16000 Common Work for Electrical.

**End of Section**

## 16902 Power Metering and Instruments

### 1.0 General

#### 1.1 Scope of Work

- .1 This section includes specifications for products, specific criteria and characteristics, methods and execution for power meters, protection relays instruments mounted in standalone enclosure.
- .2 For common criteria see Section 16000 Common Work for Electrical.

#### 1.2 Standards

- .1 All components and assemblies are to be designed, manufactured, installed and tested in accordance with the latest applicable CSA, UL/cUL/ULC, NEMA, ANSI, and/or IEEE standards.
  - .1 CAN3-C17 - Alternating-Current Electricity Metering
  - .2 CSA C22.2 No.115 - Meter-Mounting Devices
  - .3 CSA C22.2 No.229 - Switching and Metering Centres
  - .4 CSA C60044-1 - Part 1 Current Transformers
  - .5 CSA C60044-2 - Part 2: Inductive Voltage Transformers
  - .6 CSA C60044-3 - Part 3: Combined Transformers
  - .7 ANSI/IEEE C57.13 - Standard Requirements for Instrument Transformers

### 2.0 Products

#### 2.1 Instrument Transformers

- .1 Instrument transformers to CSA C60044.
- .2 Current transformers shall be wound window dry type for indoor use, 600V voltage class, 60Hz, 10kV BIL, current ratio, metering & relaying accuracy, burden, class, and continuous current rating factor as indicated, and with automatic short-circuiting capability across the secondary terminals. Where required, current transformers to be primary voltage class, with BIL rating to match the assembly's rating.
- .3 Voltage transformers shall be dry type for indoor use, voltage class and BIL rating to match assembly's rating, voltage ratio, metering accuracy and burden as indicated, and with primary and secondary fuses.

#### 2.2 Power Supply Authority Metering (UM)

- .1 Provide outdoor rated metering enclosure to be mounted on the external wall of the electrical room for the installation of the power supply metering. Panel shall be in accordance with Local Distribution Utility specifications.

#### 2.3 Customer Power Metering (PM)

- .1 Where indicated on the drawings provide separate customer metering in CSA 1 enclosure with hinged door and include the following:

- .1 Current transformers where shown on the drawings or elsewhere specified shall be wired to shorting terminal blocks.
  - .2 Voltage transformers including primary and secondary fuses with disconnecting means and fused potential taps as the potential source for metering as shown on the drawings.
  - .3 Microprocessor-based customer metering system.
  - .4 All terminal blocks shall be finger safe.
- .2 The meter shall provide true rms metered values to the 51st harmonic and be accurate to 0.15% of reading for voltage and current measurements and 0.3% of reading for power and energy measurements. The meter shall be rated for an operating temperature range of -25°C to 70°C and shall accept metering inputs from industry standard instrument transformers (120Vac secondary VT's and 5 A secondary CT's). The meter shall also have Ethernet and optional fibre-optic communication port, allowing the device to be tied into communications networks. The front panel shall also have an optical port for local communication to a personal computer.
  - .3 The information available from the customer meter front display includes
    - .1 Current, per phase rms, 3-phase average and neutral (if applicable);
    - .2 Voltage, phase-to-phase, phase-to-neutral, and 3-phase average;
    - .3 Frequency;
    - .4 Power factor, each phase and 3-phase total;
    - .5 Real, reactive and apparent power, each phase and 3-phase total;
    - .6 Real, reactive and apparent energy, each phase and 3-phase total;
    - .7 Minimum, maximum and demand – current, voltage, power and energy, per phase and three phase average;
    - .8 Individual harmonics (up to 51<sup>st</sup>) and THD, current and voltage, per phase;
    - .9 Ethernet/IP communication.
  - .4 Acceptable meters: Eaton PXM 1000, Schneider PM 8240/8244, or approved equal.

### **3.0 Execution**

#### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.

#### **3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install the equipment and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical and Section 16030 Commissioning of Electrical System.

**End of Section**

## 16920 PLC & SCADA Control and Integration

### 1.0 General

#### 1.1 General Description of Work

- .1 This specification covers the design, manufacturing, testing, commissioning and start-up of the PLC and SCADA hardware to be used for monitoring and control of the facilities.
  - .1 CP1, SCADA Control Panel
- .2 The Contractor will install the SCADA Control Panel, SCADA workstation and miscellaneous hardware, provide field wiring, perform I/O checks, assist the SCADA Integrator in commissioning and start-up, coordinate all material, information, and subcontractors to ensure that all equipment operations are complete.
- .3 The Contractor shall be responsible for management of shop drawing submission, coordination with SCADA Panel Supplier, delivery, storage, installation, field wiring and start-up and commissioning of the SCADA panels and hardware.

#### 1.2 Process System Integrator

- .1 The SCADA Integrator shall be responsible for PLC and SCADA programming, and coordination with the Contractor of system start-up and commissioning.
- .2 The Contractor shall be responsible for ensuring that the SCADA Integrator has all current information to complete the start-up and commissioning of all the equipment on time and with no impact on existing operations.
- .3 The Contractor shall coordinate all forces including subcontractors, equipment suppliers, and integrators for the checkout, start-up and commissioning of all equipment installed under this contract.

#### 1.3 Delivery, Storage and Handling

- .1 Equipment shall be handled and stored in accordance with manufacturer's instructions. One copy of these instructions shall be included with the equipment at time of shipment.

#### 1.4 Product Data and Shop Drawings

- .1 Provide product data and shop drawings in accordance with Section 16000 Common Work for Electrical.
- .2 Also include:
  - .1 Functional description.
  - .2 Physical, electrical and environmental requirements.
  - .3 Communication topology drawings.
  - .4 Equipment layout drawings showing location of hardware, boards, jacks, cables and terminals.
  - .5 Schematic wiring diagrams, interconnection diagrams including wiring, cables, jacks between internal and external components, power supplies, processors, communications modules, racks, I/O modules and peripherals; label terminals, jacks and pins.

- .6 Related field tag numbers and wire numbers, module tag assignment, rack module assignment, terminal and terminal strip numbers.
- .7 Proposed configuration/parameter sheets including switch settings and addresses.
- .8 For hardware items include description, make, model, part number and serial number.
- .9 For software items include publisher, title, version, part number, serial number, media type and size, and information contained on label.
- .10 For documentation include title and publisher for each item.

## **1.5 Operating and Maintenance Instruction Manuals, and Record Drawings**

- .1 Provide operating and maintenance instruction manuals, and record drawings in accordance with Section 16000 Common Work for Electrical.
- .2 Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include user guides, technical reference, programming manuals, instruction leaflets and instruction bulletins for the complete assembly and each major component.
- .3 Provide an updated version of the documentation provided as a shop drawing submission. This version shall reflect all modifications that occurred as part of the site acceptance testing. Also provide the record of switch settings, program listings and parameter settings, after commissioning.

## **2.0 Products**

### **2.1 PLC/SCADA Control Panel Components**

- .1 Supply and install the following PLC accessory hardware, CSA/cUL listed/certified, in quantities as required, in accordance with Section 16825 Electrical Control Devices and Relays.
  - .1 PLC Control Panel CP-1 and components, CSA/cUL listed/certified, in quantities as required and shown on drawings and schedules.

## **3.0 Execution**

### **3.1 Manufacturer's Quality Control & Factory Testing**

- .1 Provide manufacturer's quality control program and factory testing in accordance with Section 16000 Common Work for Electrical.
- .2 All incoming material shall be inspected and/or tested for conformance to quality assurance specifications. Factory test individual components and complete PLC assembly in accordance with applicable standards and include, but do not limit to, the following:
  - .1 Interchangeability of removable elements.
  - .2 Mechanical and electrical operation of circuit breakers, disconnect switches, interlocks, auxiliary switches, protective devices, manual devices.
  - .3 Functional tests on components and circuits. Simulate control signals where applicable.
  - .4 Continuity of power and control circuit wiring.
- .3 Notify the Engineer 48 hours minimum prior to tests.

**3.2 Installation, Field Quality Control, Start-up & Commissioning**

- .1 Install the equipment and provide field quality control, start-up and commissioning in accordance with Section 16000 Common Work for Electrical.
- .2 The Contractor shall coordinate the schedule with Owner, Contract Administrator, System Integrator and subcontractors to complete the project on time.
- .3 Provide necessary services to test, calibrate, start-up, fine-tune and commission the communication, control, alarm, monitoring, information and instrumentation systems provided under this specification.
- .4 Co-ordinate and verify the calibration of PLC analog interface signals for all instruments when they are being calibrated by the supplier's representative.

**3.3 Manufacturer's Certification and Training**

- .1 Provide manufacturer's certification and training in accordance with Section 16000 Common Work for Electrical.

**End of Section**

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**SECTION F - FOR INFORMATION ONLY – FM REFERENCE DRAWING**



The Ontario Provincial Standard Specifications are to be taken and read as part of this Contract.

The Ontario Provincial Standard Drawings are also to be taken and read as part of this Contract.

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